RAILROAD GAZETTE

A Journal of Transportation, Engineering and Railroad News.

QUARTO VOL. II.—NO. 13. Fourteenth Year. | CHICAGO, SATURDAY, DECEMBER 24, 1870. | $3.00 per Annum, until 1871. $4 per Annum, thereafter.

Contributions.

ANALYSIS OF THE POST AND LINVILLE TRUSSES.

A Comparison of their Weights when Properly Proportioned, Each Having the Same Span, Depth, and Assumed Weights, and Each Carrying the Same Live Load.

BY DR VOLSON WOOD,

Professor of Civil Engineering in the University of Michigan.

Colonel Merrill, in his work on "Iron Truss Bridges for Railroads," has made a comparison of these trusses, as well as of several others; and according to his analysis he concludes that the Post truss requires less material than any of the others with which the comparison was made. But he made certain assumptions in regard to the Linville truss which, I think, are not correct. The fundamental error is in assuming that "an increase of depth does not cause an increase in the amount of material in properly proportioning the truss." See page 103 of his work. The only show of proof which he gives is, "that what is lost by increasing the lengths of posts and braces is made up by a diminution of the strains." It is true that the strains on the chords are diminished as the depth increases, but it is not true that the weight diminishes in the same ratio as the strain. Taking the formula given by Colonel Merrill for the weight of a column or pillar, given on page 51,

$$P = 0.00459961\ (5)^{\frac{1}{1.88}} \times l^{\frac{1.79}{0.94}} \times w^{\frac{1}{1.88}}$$

in which l = the length of the column,

w = the compressive strain in pounds, and

P = the weight,

and we observe that the weight varies as $\frac{1}{1.88}$ power of the strain; while the weight of the posts varies as $\frac{1.79}{0.94} = 1.90$, power of the length. As the latter exceeds the reciprocal of the former, it follows that the weight of the post increases in a more rapid *ratio* than that of the chord diminishes. As the strain on the chords in the example before us exceeds that on the posts, it would appear that a simple increase in the depth would considerably decrease the weight. But if there be an increase in the depth and a corresponding diminution in the number of posts, so that the ties which incline at at an angle of 45 degrees shall cross two panels, or what is the same thing, the depth of the truss shall equal the length of two bays, then there will be an increase in the weight. This Colonel Merrill has done. He made the length of the bays the same as in the Post truss and then determined the depth of the truss, instead of making the depths the same and determining the lengths of the bays. To illustrate the effect of this increase, suppose that the depth of the truss is doubled, then the stress on the chords is only half as great; and if the length of the bays be half the depth of the truss, and if the formula given above gives the weight in the former case, the weight in the latter case will be:

$$P' = 0.00459961\ (5)^{\frac{1}{1.88}} \times (2)^{\frac{1.79}{0.94}} \times l^{\frac{1.79}{0.94}} \times (\tfrac{1}{2})^{\frac{1}{1.88}} \times w^{\frac{1}{1.88}}$$

$$= 0.00459961\ (5)^{\frac{1}{1.88}}\ l^{\frac{1.79}{0.94}} \times w^{\frac{1}{1.88}} \times \tfrac{1}{2}\,(2)^{2.37}.$$

From this it appears that the weight of the chords will be $\frac{1}{2}\,(2)^{2.37} = 2.584$ times as great. To this must be added the increased weight of the posts and ties. His assumption then discriminates against the Linville truss.

The principal reason why Colonel Merrill made this assumption seems to be that he desired to make the lengths of the bays the same as in the other trusses, and make the ratio between the depth and length conform more nearly with that used by the manufacturers. But if it shall appear that the Linville truss is lighter than the Post when they have the same depth, then if the former is made heavier than the latter in practice, it is not the fault of the system. The true way to compare the *systems* is to find that depth of the truss and length of the bays for each that will require the least material for each, and then compare the results. But there is no simple relation between the depth and span which will fulfil this condition. The length of the bays is often determined, as in the present case, from the depth of the truss.

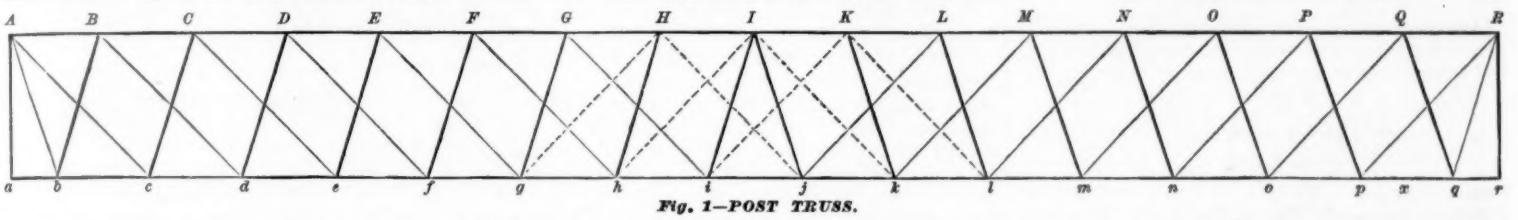
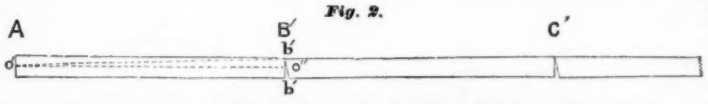


Fig. 1—POST TRUSS.

Fig. 2.



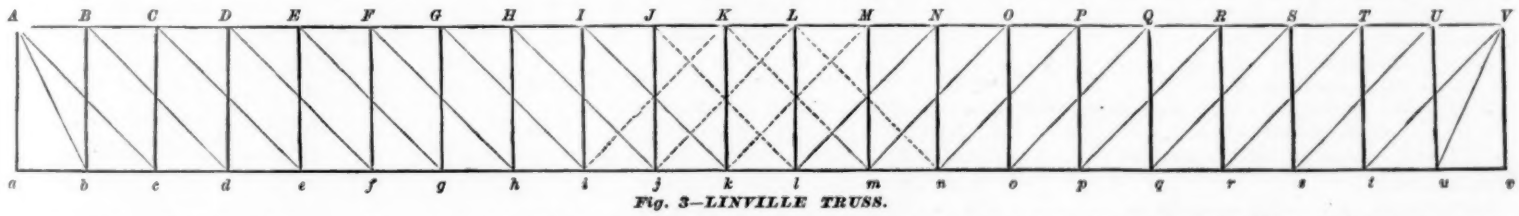


Fig. 3—LINVILLE TRUSS.

It is not my purpose to solve the more general problem, but to analyze the trusses on the conditions given in the heading of this article. For the purpose of simplifying the solution, I will assume an uniform load, and will take it equal to a train of locomotives of the same weight as that assumed by Colonel Merrill. This is equally fair for both trusses, but will not make so large an array of figures as it would to assume that they are loaded partly with a locomotive, partly with a tender of different weight, and the remaining part with cars of still different weight. The weights of the trusses were found by Colonel Merrill to be, for the Post truss, 225,527 pounds; for Linville, 234,021 pounds. The same trusses were computed by one of my students, Mr. H. C. Ripley, in his graduating thesis, last June, and he found, for the Post truss, 221,213 pounds, and for the Linville, 219,412 pounds. The former assumed the weights of the trusses, each to be 300,000; the latter assumed 280,000 pounds. I will assume 210,000 pounds.

By the weight of the *truss* I mean so much of the weight of the *bridge* as produces strains on the truss, and not those pieces at each end which are supported directly by the abutments. To get the full weight of the *bridge*, the weight of the latter pieces must be added. For instance, in the Post truss, the post $A\,a$, the ties $A\,b$ and $A\,c$, and one half the segments of the chords AB and ab are supported directly by the abutments and cause no strain on the trussing; and the same is true at the other end. So far as the weight of the bridge in producing strains is concerned we may assume that it is concentrated in equal weights at the joints of the lower chord, except the end ones at b and q. These sustain more than three-fourths as much as the others; for they sustain one half ac, one-half ab, which together make three-fourths of ac; also one-half of AB, which equals one-half of bc. I will therefore assume that the load on on each of the joints due to the weight of the truss is equal. But the weight on b due to an uniform live load will be three-fourths that on the other joints, for the whole load rests on the lower chord.

THE POST TRUSS.

We have, Span ar = ...	200 feet	$= L$
Depth of truss.....	18 " 9 in.	$= D$
No. of panels.....	16 "	$= N$
Panel length.....	12 " 6 in.	$= l$
Panel weight of engine.	17,600 pounds	$= e$
Panel weight of one truss	6,562½ "	$= w$

The span, depth, number of panels, and weight of engine are the same as those assumed by Colonel Merrill.

In the Post truss the posts have a run of half a bay, and the ties have a run of a bay and a half and are inclined at an angle of 45 degrees.

TIES AND BRACES.

To find the maximum strain on the ties and posts, suppose that the live load extends over the whole length of the truss and moves off, without shock, in the direction from r towards a. The maximum strain on Rr and Rq will be when the load extends the whole length; on $R\,p$ when the load extends from p to a; on oQ and Qq when it extends from o to a and so on to the centre, beyond which we get the maximum on the counter-ties only: and to get the maximum on the other half of the bridge we suppose that the live load moves in the opposite direction and consider the maximum on the posts and main ties to the centre and on the counter ties beyond the centre, as before. The results are entered in the annexed table. To show how they are obtained take cD, for example, and consider first the moving load. The strain is produced by a load of three-fourths e at b and e at c. A portion of the strain due to three-fourths e is transmitted through bc, thence to c, thence through cD, and so on to r. Similarly the strain due to e at c is transmitted through cD, and so on to r. Hence, if we find how much of the weight is sustained at r, we find how much is transmitted through cD by multiplying the result by the secant of the inclination. This is easily found by moments. Taking the origin of moments at a, the lever arm of three-fourths e is ab = one-half a bay; of e at c is ac = 1½ bays; and the arm of the moment of the reaction at r is 16 bays.

$$\text{Hence we have } 16 \times \text{reaction} = \tfrac{3}{4}\,e \times 1\tfrac{1}{2} + e \times \tfrac{3}{2}$$

$$\therefore \text{reaction} = \tfrac{15}{128}\,e.$$

In a similar way find the stress due to the weight of the truss, by observing that it is loaded the whole length by the weight of the truss. Or, observe that the strain at the middle due to the weight of the truss is zero, and increases each way from the center. The secant of the inclination is $\sqrt{2}$. The length of a tie is $18.75\sqrt{2}$.

POSTS.

The *vertical* strain on the posts is the same as the vertical strain on the ties, except at the center. When the train extends from the center to one end of the bridge, it is impossible to tell exactly how much is sustained by $I\,i$ and $I\,j$ respectively, but the most rational assumption, and the one made by Colonel Merrill and others is, that each transmits half the strains from I to the lower chord. The end post $r\,R$ sustains the vertical force on both $p\,R$ and $q\,R$. The vertical stress multiplied by the secant of the inclination gives the actual stress. The length of a post is $\frac{1}{4}\sqrt{10} \times 18.75$ feet.

CHORDS.

The maximum strain on chords is produced by a load extending the whole length of the span. The strain on any bay is most easily found by the principle of moments. For example, take $n\,o$. If this piece be severed the truss may fall by turning about O or P. To find the strain on $n\,o$, suppose that the truss is separated into two simple ones, one being composed of the parts $r\,R$, $R\,p$, $p\,P$, $P\,n$, etc; and the other of $r\,R$, $R\,q$, $q\,Q$, $Q\,o$, $o\,O$, $O\,m$, etc. We find the strain on $n\,p$ for the first partial truss, and on $o\,m$ for the second, and add the results for the strain on $n\,o$. Let V_1 be the amount sustained at r for the first truss, and V_2 that sustained by the second truss. By examining the table of strains on the ties, we see that for the first truss

$$V_1 = \tfrac{1053}{256}\,e + 4\,w$$

and weight at $q \quad = \frac{3}{4}\,e + w$

From Q let fall the perpendicular $Q\,x$ on the lower chord. From the data given find $q\,x = \frac{1}{2}\,q\,p$. The lever arm of V_1 is $r\,x = l$, of $\frac{3}{4}\,e + w$ it is $q\,x = \frac{1}{2}\,l$; and the moments of the two have contrary signs. The arm of the strain in $o\,q$ is $Q\,x = D$. Call this strain H_1, and the equation of the moments is

$$H_1\,D = V_1\,l - (\tfrac{3}{4}\,e + w)\,\tfrac{1}{2}\,l;\ \text{but}\ D = \tfrac{3}{5}\,l$$

$$\therefore H_1 = \left[\left(\tfrac{1053}{256}\,e + 4\,w\right) - \tfrac{1}{2}\,(\tfrac{3}{4}\,e + w)\right]\tfrac{5}{3} = \tfrac{957}{384}\,e + \tfrac{7}{3}\,w.$$

For the other partial truss, let fall a perpendicular from P to the lower chord. Calling the strain on $n\,p$ for this part of the truss H_2, we find:

$$H_2\,D = \left[\left(\tfrac{931}{256}\,e + 4\,w\right)l - (\,e + w\,)\,\tfrac{1}{2}\,l\,\right]$$

$$\therefore H_2 = \tfrac{1734}{384}\,e + \tfrac{15}{3}\,w.$$

Hence the strain on $o\,p$ is

$$H_1 + H_2 = \tfrac{2691}{384}\,e + \tfrac{22}{3}\,w,$$

as given in the table.

In a similar way the strains on any part of the upper or lower chord are found and entered in the table. The length of each regular bay, which is the length of the pieces of the chord, is 12½ feet.

WEIGHTS.

Having found the strains we next find the weights. Using, as Colonel Merrill does, five times the strain for safety, we may adopt the same formula that he does, as given on page 51.

Let W = the strain,
l = the length of the piece,
T = the weight of the wrought iron prismatic piece subjected to tension,
P = the weight of cast iron columns;

then $T = \frac{l\,w}{3000}$

$$P = 0.00459961 \times 5^{\frac{1}{1.88}} \times l^{\frac{1.79}{0.88}} \times w^{\frac{1}{1.88}}$$

By means of these formulas I have computed the weights as given in the columns.

EXTRA STRAINS.

Colonel Merrill, after having computed the compression on the posts as we have done, says, (p. 89): "We "must then add $\frac{1}{12}$ the then compression of the top "chord into the secant of the inclination with the ver- "tical." This conclusion he arrives at on pp. 23 and 24, where he remarks that "Imperfections of workmanship, "the ends of the chords being not truly faced perpen- "dicular to the axes, may cause the center of pressure "to be above or below the center of the figure of the "end, or this eccentricity may arise from defective "adjustment of the bridge, causing sagging in some "places and a tendency to rise in others."

On account of the elasticity of the material this bridge will sag, or deflect, about 7 inches in the center; call it 8 inches, and then the increased downward pressure due to this sag at the center will be $\frac{8}{200 \times 12} = \frac{1}{300}$, — a comparatively small amount. But this is not the cause which is considered by Colonel Merrill. Let figure 2 represent a portion of the upper chord, $b\,b$ its depth, and $A'B'$ the length of one panel, as AB, figure 1. Any tendency to sag will cause the joints to open at the bottom, and the pressure, instead of being transmitted from o' to o'' in the direction of the center line of the chord, will pass to b. This will cause an *upward* component represented by $o''b$. If the chord is now horizontal, the pressure from b extends horizontally until it reaches the last point shown at Q, where there will be a deflection as from b to o'. Thus it appears that there will be no tendency to produce extra strains except at B and Q, and if the depth of the chord be 9 inches, the strain will be about 2,600 pounds *upwards;* and as this is less than the downward strain, there appear to be no extra strains. There may be *ideal* cases in which the points of contact will fall below a horizontal,—or some above and others below the line joining the ends of the chords. But they are hardly *practical* cases, for it is customary to give the bridge so much camber that ordinary loads will not more than bring it down to a horizontal. And even it it should sag below that line for an excessional load it would be exceptional workmanship that would cause the points of contact to be on the lower side. It may be asked if a load extending over a portion of the length may not cause an extra strain. If a load extending the whole length does not bring the chord to a horizontal, a partial load will not bring any part of it to that line. If sufficiently cambered there will be no extra strains, and hence I have not allowed any. I think it a very poor condition or very poor workmanship, or both, that gives one-seventeenth extra strain; although they may *possibly* exist.

LINVILLE TRUSS.

Let the span and depth and total load be the same as for the Post truss, and

Number of panels ..... = 21 = N.
Panel weight of one truss = 5,250 = w.
" " load = 13,640 = E.

In the Linville truss the posts are vertical, and the ties are inclined at an angle of 45 degrees. In figure 3 the ties cross two panels.

Suppose that the load is sustained at the joints of the lower chord. There are 20 equal weights. Suppose the load is on the whole length. For this case we have the maximum strains on the upper and lower chords, which strains are found by the principle of moments, the same as before. For instance, suppose the truss is divided into two simple partial ones; then find the strain on $O\,Q$ for one by taking the origin of moments at o, and the strain on PN by taking the origin of moments for the other at n. The sum of the two strains will be the strain on $P\,O$, as given in the table.

TIES AND POSTS.

To find the maximum strain on the ties and posts, suppose that the load moves off without shock. The maximum strain on nP and Pp takes place when the load extends from n to a, including n. Its amount may be found, as in the Post truss, by conceiving that the truss is separated into two simple ones and then finding the amount which is transmitted by each to r. The results are entered in the table.

WEIGHTS.

The same formulas are used to determine the weights of the several parts as were used for the Post truss.

TABLES OF STRAINS AND WEIGHTS OF THE POST TRUSS.

Maximum Tension on the Ties.

Strains.		Weight. T.
$q\ R$ —	$\left(\frac{1053}{256}E + 4\,w\right)\frac{1}{10}\sqrt{10}$ — 103,979	571
$p\ R$ —	$\left(\frac{931}{256}E + 4\,w\right) \times \sqrt{2}$ — 117,542	866
$o\ Q$ —	$\left(\frac{867}{256}E + 3\,w\right) \times \sqrt{2}$ — 112,138	826
$n\ P$ —	$\left(\frac{699}{256}E + 3\,w\right) \times \sqrt{2}$ — 95,804	706
$m\ O$ —	$\left(\frac{651}{256}E + 2\,w\right) \times \sqrt{2}$ — 81,856	603
$l\ N$ —	$\left(\frac{499}{256}E + 2\,w\right) \times \sqrt{2}$ — 67,078	494
$k\ M$ —	$\left(\frac{467}{256}E + w\right) \times \sqrt{2}$ — 54,685	403
$j\ L$ —	$\left(\frac{331}{256}E + w\right) \times \sqrt{2}$ — 37,927	280
$i\ K$ —	$\left(\frac{315}{256}E + 0\right) \times \sqrt{2}$ — 30,627	226
$h\ I$ —	$\left(\frac{195}{128}E + 0\right) \times \sqrt{2}$ — 37,919	286
$g\ H$ —	$\left(\frac{143}{128}E - w\right) \times \sqrt{2}$ — 18,526	137
$f\ G$ —	$\left(\frac{99}{128}E - w\right) \times \sqrt{2}$ — 9,405	69
$e\ F$ —	$\left(\frac{63}{128}E - 2\,w\right) \times \sqrt{2}$ — Negative....	
$d\ E$ —	$\left(\frac{35}{128}E - 2\,w\right) \times \sqrt{2}$ — "	
$c\ D$ —	$\left(\frac{15}{128}E - 3\,w\right) \times \sqrt{2}$ — "	
$b\ C$ —	$\left(\frac{3}{128}E - 3\,w\right) \times \sqrt{2}$ — "	
Total.....		5,467

Maximum Compression on the Posts.

		P
$r\ R$ —	$\frac{1984}{256}E + 8\,w$ — 188,900.....	1,842
$q\ Q$ —	$\left(\frac{867}{256}E + 3\,w\right)\frac{1}{3}\sqrt{10}$ — 81,335.....	1,498
$p\ P$ —	$\left(\frac{699}{256}E + 3\,w\right)\frac{1}{3}\sqrt{10}$ — 69,160	1,198
$o\ O$ —	$\left(\frac{651}{256}E + 2\,w\right)\frac{1}{3}\sqrt{10}$ — 59,513.....	1,102
$n\ N$ —	$\left(\frac{499}{256}E + 2\,w\right)\frac{1}{3}\sqrt{10}$ — 48,498.....	988
$m\ M$ —	$\left(\frac{467}{256}E + w\right)\frac{1}{3}\sqrt{10}$ — 40,011.....	893
$l\ L$ —	$\left(\frac{331}{256}E + w\right)\frac{1}{3}\sqrt{10}$ — 29,195.....	755
$k\ K$ —	$\left(\frac{315}{256}E + 0\right)\frac{1}{3}\sqrt{10}$ — 22,827.....	662
$j\ J$ —	$\left(\frac{195}{256}E + 0\right)\frac{1}{3}\sqrt{10}$ — 14,131.....	512
Total.....		9,450

Maximum Tension on the Lower Chord.

On		T
$a\,b$ or $q\,r$ —	o	
$b\,c$ or $q\,p$ —	$\frac{957}{384}E + \frac{7}{3}\,w$ — 59,174.....	205
$c\,d$ or $p\,o$ —	$\frac{2691}{384}E + \frac{22}{3}\,w$ — 171,462.....	595
$d\,e$ or $o\,n$ —	$\frac{4584}{384}E + \frac{38}{3}\,w$ — 282,287.....	980
$e\,f$ or $n\,m$ —	$\frac{5763}{384}E + \frac{44}{3}\,w$ — 360,387.....	1,257
$f\,g$ or $m\,l$ —	$\frac{6589}{384}E + \frac{51}{3}\,w$ — 413,558.....	1,435
$g\,h$ or $l\,k$ —	$\frac{7599}{384}E + \frac{58}{3}\,w$ — 475,162.....	1,650
$h\,i$ or $k\,j$ —	$\frac{7677}{384}E + \frac{61}{3}\,w$ — 485,200.....	1,685
$j\,i$ —	$\frac{8965}{384}E + \frac{64}{3}\,w$ — 509,646(½)....	885
Total.....		8,686

Maximum Compression on the Upper Chord.

On		P
$R\ Q$ —	$\frac{1282}{256}E + \frac{16}{3}\,w$ — 119,805.....	668
$Q\ P$ —	$\frac{2430}{256}E + \frac{26}{3}\,w$ — 228,414.....	943
$P\ O$ —	$\frac{3330}{256}E + \frac{40}{3}\,w$ — 326,437.....	1,139
$O\ N$ —	$\frac{4137}{256}E + \frac{48}{3}\,w$ — 389,420.....	1,249
$N\ M$ —	$\frac{4696}{256}E + \frac{56}{3}\,w$ — 445,350.....	1,347
$M\ L$ —	$\frac{5161}{256}E + \frac{60}{3}\,w$ — 487,068.....	1,409
$L\ K$ —	$\frac{5378}{256}E + \frac{64}{3}\,w$ — 499,738.....	1,428
$K\ T$ —	$\frac{5502}{256}E + \frac{64}{3}\,w$ — 508,273.....	1,441
Total —		9,624

The sum of these gives the weight of one truss. We have

Weight of ties —	5,467	pounds.
" " posts —	9,450	"
" " lower chord —	8,686	"
" " upper " —	9,624	"
Total	33,227	"
	2	
Multiply by two and we have weight of one truss = ...	66,454	"

Omitting for the present the weight of the other parts of the bridge, we proceed to find the weight of the

LINVILLE TRUSS.

Maximum Tension on the Ties.

		T
$b\ A$ —	$\left(\frac{110}{21}E + 5\,w\right)\frac{1}{2}\sqrt{5}$ — 109,228.....	636
$c\ A$ —	$\left(\frac{100}{21}E + 5\,w\right) \times \sqrt{2}$ — 129,247.....	952
$d\ B$ —	$\left(\frac{90}{21}E + 4\,w\right) \times \sqrt{2}$ — 112,365.....	828
$e\ C$ —	$\left(\frac{81}{21}E + 4\,w\right) \times \sqrt{2}$ — 104,312.....	768
$f\ D$ —	$\left(\frac{72}{21}E + 3\,w\right) \times \sqrt{2}$ — 88,407.....	651
$g\ E$ —	$\left(\frac{64}{21}E + 3\,w\right) \times \sqrt{2}$ — 72,999.....	538
$h\ F$ —	$\left(\frac{56}{21}E + 2\,w\right) \times \sqrt{2}$ — 66,285.....	483
$i\ G$ —	$\left(\frac{49}{21}E + 2\,w\right) \times \sqrt{2}$ — 59,849.....	441
$j\ H$ —	$\left(\frac{42}{21}E + w\right) \times \sqrt{2}$ — 46,004.....	339
$k\ I$ —	$\left(\frac{36}{21}E + w\right) \times \sqrt{2}$ — 40,490.....	299
$l\ J$ —	$\left(\frac{30}{21}E \pm 0\right) \times \sqrt{2}$ — 27,556.....	203
$m\ K$ —	$\left(\frac{25}{21}E \pm 0\right) \times \sqrt{2}$ — 22,999.....	169
$n\ L$ —	$\left(\frac{20}{21}E - w\right) \times \sqrt{2}$ — 10,917.....	81
$o\ M$ —	$\left(\frac{16}{21}E - w\right) \times \sqrt{2}$ — 7,272.....	54
$p\ N$ —	$\left(\frac{12}{21}E - 2\,w\right) \times \sqrt{2}$ — Negative...	
$q\ O$ —	$\left(\frac{9}{21}E - 2\,w\right) \times \sqrt{2}$ — " ...	
$r\ P$ —	$\left(\frac{6}{21}E - 3\,w\right) \times \sqrt{2}$ — " ...	
$s\ Q$ —	$\left(\frac{4}{21}E - 3\,w\right) \times \sqrt{2}$ — " ...	
$t\ R$ —	$\left(\frac{2}{21}E - 4\,w\right) \times \sqrt{2}$ — " ...	
$u\ S$ —	$\left(\frac{1}{21}E - 4\,w\right) \times \sqrt{2}$ — " ...	
Total		6,442

Maximum Compression on the Posts.

On		P
$a\ A$ —	$10\,E + 10\,w$ — 188,900.....	1,841
$b\ B$ —	$\frac{90}{21}E + 4\,w$ — 79,457.....	1,162
$c\ C$ —	$\frac{81}{21}E + 4\,w$ — 73,621.....	1,115
$d\ D$ —	$\frac{72}{21}E + 3\,w$ — 62,514.....	1,024
$e\ E$ —	$\frac{64}{21}E + 3\,w$ — 57,319.....	977
$f\ F$ —	$\frac{56}{21}E + 2\,w$ — 49,393.....	902
$g\ G$ —	$\frac{49}{21}E + 2\,w$ — 44,531.....	854
$h\ H$ —	$\frac{21}{42}E + w$ — 34,420.....	745
$i\ I$ —	$\frac{36}{21}E + w$ — 30,253.....	695
$j\ J$ —	$\frac{30}{21}E + o$ — 19,486.....	550
$k\ K$ —	$\frac{25}{21}E + o$ — 16,238.....	499
Total —		10,304

Maximum Tension on the Lower Chord.

ON	T
$v\ u$ — 0	
$u\ t$ — $\frac{15}{2}(E+w)$ — 47,225	125
$t\ s$ — $\frac{15}{2}(E+w)$ — 141,675	380
$s\ r$ — $\frac{23}{2}(E+w)$ — 217,235	575
$r\ q$ — $\frac{31}{2}(E+w)$ — 292,795	775
$q\ p$ — $\frac{37}{2}(E+w)$ — 349,465	920
$p\ o$ — $\frac{43}{2}(E+w)$ — 406,135	1,074
$o\ n$ — $\frac{47}{2}(E+w)$ — 443,915	1,174
$n\ m$ — $\frac{51}{2}(E+w)$ — 481,695	1,274
$m\ l$ — $\frac{53}{2}(E+w)$ — 500,585	1,324
$l\ k$ — $\frac{55}{2}(E+w)$ — 519,475 (half)	687
Total —	8,308

Maximum Compression on Upper Chord.

ON	P
$V\ U$ — $\frac{15}{2}(E+w)$ — 141,675	435
$U\ T$ — $\frac{23}{2}(E+w)$ — 217,235	547
$T\ S$ — $\frac{31}{2}(E+w)$ — 292,795	640
$S\ R$ — $\frac{37}{2}(E+w)$ — 349,465	705
$R\ Q$ — $\frac{43}{2}(E+w)$ — 406,135	761
$Q\ P$ — $\frac{47}{2}(E+w)$ — 443,915	798
$P\ O$ — $\frac{51}{2}(E+w)$ — 481,695	834
$O\ N$ — $\frac{53}{2}(E+w)$ — 500,585	851
$N\ M$ — $\frac{55}{2}(E+w)$ — 519,475	868
$M\ L$ — $\frac{55}{2}(E+w)$ — 519,475	868
$L\ K$ — $\frac{55}{2}(E+w)$ — 519,475 — ½	434
Total	7,741

Hence we have:	Pounds.
Weight of ties —	6,442
" posts —	10,364
" lower chord —	8,308
" upper chord —	7,741
Total —	32,855
	2
Multiplied by 2, weight of one truss —	65,710

The computation thus far is for a mere skeleton *truss*, and hence something must be added for connections, pins, bolts, cross-ties, floor and track to find the full weight of the *bridge*. Some of these might be computed, but instead of attempting it, we will follow the plan of Colonel Merrill, and add the same quantities he did, except in one case, and that is that we will add 15 per cent. of the above weights, as he said he proposed to, for mechanical connections, but for which he only added one-fifteenth in his computations.

He adds:

For iron floor-beams	100.80 lbs.	per foot.
Top lateral struts	21.60 "	"
" " ties	24.00 "	"
Track (including rails, ties, etc., etc.,)	245.60 "	"
Total	392.00 "	"

And for half the bridge we multiply this by 100. Hence we have for the

POST TRUSS.

Weight of one truss	66,454 lbs.
" 15 per cent	9,968 "
" of floor, etc., etc., as above	39,200 "
Weight of half the bridge	115,622 "
Total weight of bridge	231,244 "

FOR THE LINVILLE TRUSS.

Weight of one truss	65,710 lbs
" 15 per cent	9,857 "
Half weight of floor etc., etc., as above	39,200 "
Weight of half the bridge	114,767 "
Total weight of the bridge	229,534 "

CONCLUSION.

Total weight of Post truss	231,244 lbs.
" " Linville truss	229,534 "
	1,710 "

We see that the Linville truss is lighter than the Post truss and the difference in this example is 1,710 pounds.

REMARKS.

To ascertain whether the weight of the bridge is greater than that assumed, we must subtract from the above those portions of the bridge which are directly supported by the abutment. In the Post truss we subtract four times the weight of $\frac{1}{2}\ p\ R$, $\frac{1}{2}\ q\ R$, $r\ R$, half of $Q\ R$, and 15 per cent. of these, and the weight of floor, etc., for half a bay These weights amount to nearly 16,000 pounds, which deducted from the above leaves about 215,000 pounds.

For the Linville truss, deduct four times one-half of $c\ A$ and $b\ A$, all of $a\ A$, and half of $v\ u$, and 15 per cent of these, and the weight of the floor etc., of one bay (half at each end). These amount to about 16,000 pounds, which, deducted from the total leaves 213,534 pounds. We say *about*, for we have no interest in determining this amount to nearer than 1,000 pounds. We see that the assumption of the weight is at a mean value about 5,000 pounds less than the computed value, or 25 pounds per linear foot. It matters not that the resultant weight is less than the usual weight of such structures having the same span, for we see no reason to suppose that doubling the weight of both bridges would essentially change the relation of their weights to each other.

If my analysis is correct, there must be some fallacy in the problem which Colonel Merrill has solved on pp. 121 and 122, under the head, "The Best Angle for a Set of Struts," from which he concludes that the most "economical angle for the parallel struts is 39° 49' with the "vertical." In regard to it I observe, in the first place, that according to the data given and the hypothesis assumed, his conclusion is correct, but in the next place I observe that it is not necessary that the braces should meet in the middle, as in the panel system for instance, *and more especially that the number of bays and of braces may be entirely independent of the length of the projection of the brace on the lower chord.* He has assumed that it is a multiple of this projection. To illustrate, let the problem be stated just as he has given it, and using the same notation that he does, in which

W — the weight,
h — depth of the truss,
b — the projection of the brace on the chord,
$E\ d$ — the strain on the brace,

and we find, as he does, that

the strain on the brace $= E\ d = \frac{W\sqrt{b^2+h^2}}{2\ h}$;

the number of braces $= \frac{L}{b}$, and the volume

$$= \text{constant} \times \frac{L}{b} \times \left[\frac{W\sqrt{b^2+h^2}}{2\ h}\right]^m \times \left[\sqrt{b^2+h^2}\right]^n$$

in which m is the exponent of the strain $= \frac{1}{1.86}$ and $n = \frac{1.79}{0.91}$, the exponent of the length. But now suppose that the number of struts is arbitrary, as it may be, since "they are independent of the angle of the connecting ties." Let the number be A; then the volume of the whole

$$= A \times \text{constant} \times \left[\frac{W\sqrt{b^2+h^2}}{2\ h}\right]^m \left[\sqrt{b^2+h^2}\right]^n$$

which we see from mere inspection is a minimum when $b = 0$; or *the strut is vertical*, as in the Linville, Whipple, Murphy-Whipple and other similar trusses.

But this is not the true problem to be solved for a minimum amount of material in the ties and braces. It may be stated with various conditions, but a fair one is: having given the number of bays, it is required to find the inclination of the ties and braces, so that the quantity of material in both shall be a minimum. This gives rise to a transcendental equation which is too complex to be of any interest in this connection. But it shows that the struts will be nearly but not quite vertical.

Colonel Merrill found from his analysis that a certain triangular truss was lighter than the Linville truss, but I should expect from my reasoning and analysis in the example before us to find that it is *heavier* than the Linville, and even heavier than the Post truss. Mr. Ferguson, one of my students, found by a rigid analysis that such was the case.

Since the weight of the compression members varies nearly as the square of their length, and the weight of the tension pieces varies simply as the length, the length of the latter should be sacrificed for the former; and in the ties and braces this is easily done by making the latter more nearly vertical. I do not say *exactly* vertical, for when both ties and braces are considered, the proper inclination is still an open question. But it is certain from the example we have solved that they should not incline so much as they do in the Post truss. For economy of weight it is better to make them vertical.

We see that the difference in weight is quite too small to establish the superiority of one over the other. The simplicity of the details, the ease with which they may be erected, their liability to get out of repair, and the ease with which they may be repaired are more vital questions than the mere saving of a few pounds of iron. Still the question of form is a very important one. Lightness in itself is desirable, but other qualities are equally desirable, and the engineer should seek to combine as many good qualities as possible.

Although the Post truss is somewhat heavier than the Linville truss, yet it has some advantages of a practical character which it is proper to notice. If they have the same depth and the ties make two intersections—or in other words, cross two panels—and the ties incline at an angle of 45 degrees, as they do in practice in both systems, then the number of bays and panels in the Linville, or any other panel system, is about 25 per cent. greater than the Post truss. In the example which I have analyzed, the Post truss has 16 panels and the Linville 21 panels, so that for the same space and depth the Post truss has fewer posts, fewer ties, and a less number of parts in the chords; the length of the chords is the same, the length of the ties the same as, and the length of the posts $\frac{1}{3}\sqrt{10} = 1.054$ longer than the corresponding parts of the Linville truss. A comparison of the results shows that the total weight of the ties and posts in the Linville truss exceeds considerably the total weight of the same pieces in the Post truss. This excess, however is more than made up by the greatly diminished weight of the upper chord, which is caused by the shorter pieces of which it is composed, in the example before us. As we have seen, the weight increases nearly as the square of the length of the compression members.

I am aware that the depth of the Linville truss in practice is made greater in proportion to its length than I have here supposed, and that without regard to theoretical considerations it thus possesses certain practical advantages; but there is nothing in the Post truss to prevent its having the same depth and the same corresponding practical advantages, if there are any, over a less depth. Many questions must be considered before it is safe to conclude that one is unquestionably superior to the other.

A LETTER FROM MR. FAIRLIE.

9 VICTORIA CHAMBERS, London S. W.

TO THE EDITOR OF THE RAILROAD GAZETTE:

Through the kindness of a friend I have been permitted to look over your issue of November 12 and have read therein a very interesting description of an improved locomotive engine, by Mr. Forney, of New York, (to whom I wish all success, for he has taken a step in the right direction), and your editorial on my paper read at Liverpool; and with your kind permission I shall say a word or two respecting these.

Mr. Forney must go a step further and make his engine rest on two bogies, and not on one only. He may then drive either the one or both, as circumstances may require the adhesion of *all* the weight or part only. By doing this he will arrive at the Fairlie single-boiler, double-bogie engine, two large photographs of one of these engines now working on the Great Southern & Western Railway of Ireland I have the pleasure to send you this mail, one showing the engine complete ready for working, the other with the driving bogie taken from under the boiler end. The boiler, tanks, etc., are all on one framing, under which two bogies are placed similar to your cars, that under the boiler having cylinders and the usual gearing attached to it called the driving bogie, and the other under the tank and fuel bunkers for carrying these only.

The centre line of this engine, like that of your cars, is a chord on any curve the bogies may be traversing, whilst the bogies themselves are tangent to it.

If you will be good enough to extract the substance from Mr. Forney's reasons for recommending his design, you will find that they aim at the root of the reasoning on which Mr. W. W. Evans builds his castles in the air.

The conclusions which you are pleased to draw respecting my paper on grades may appear very logical, but they are not correct; and I will venture to say had you given more consideration to the subject you would have written in a very different strain.

I cannot understand how you could have avoided seeing in my paper that the proportions of dead to paying load therein given are the practical results of our working in this country: I could not mean yours because I know very little about your railways or their working; but this I do know, gathered from your own article, that you do not know this any more than I do, and I venture to say if you will honestly ascertain the number of passenger and merchandise cars run on any line you like to take (as an example) in every train, the number of miles run by every train, and the number of passengers and tons carried by each car in every train, that you will find the proportions of 29 to 1 in the one case and 7 to 1 in the other much nearer the mark than the figures you give.

I am quite prepared to admit that your cars with either passengers or freight run with greater average loads than they do with us—that is, that each car has nearer its maximum number of passengers or tons of freight in it at all stages of its running. Nevertheless I am quite positive that on investigation (you do not appear to have looked at the matter in this light at all) you will find the proportion of dead to paying load actually carried very different to what you imagine it to be. Remember it is not what could be carried, but what is actually carried that you have to look at.

I am rather surprised that you should have made the mistake in your figures of calculating the capacities of

your trains as to what they might carry instead of what they actually do carry, and it is this same character of mistake that you make regarding my paper all through your article.

The figures I have given are extracted not only from companies half-yearly balance sheets, but from the Board of Trade published returns and are universally admitted in this country.

To prove to you the enormous disproportion between that which is and that which might be the case with *our* trains I give the following particulars of our stock in comparison with those which you give:

Our 1st-class carriages carry....32 persons and weigh 7 tons. (or have seats for 32 persons).....		
Our 2d-class carriages carry.....40 persons and weigh 6 tons, 5 cwt.		
" 3d " " " 50 " " 7 "		
	122	20 tons 5 cwt.

being equal to about 3 cwt. of carriage to passenger, whilst yours is 152,000 lb. or 67¾ tons to 240 passengers, being equal to 5-6 cwt. to 1 passenger, or nearly double that of the dead weight to seating capacity of our stock.

Our wagons average 4.5 to carry 8 tons, or 1.77 of paying to 1 of dead weight, whilst yours is (still quoting your figures) only 1 to 1. Thus, if our dead weight in passenger stock is only some 45 per cent. of that of yours, and in merchandise stock about 38 per cent. less than yours, whilst the actual results of the working of stock show so great a discrepancy in respect to these, it surely follows that—allowing a considerable margin for your better working, *i. e.* for your better filling your trains—there is still a great deal to make up, and as I have said on an honest investigation your dead to paying weight will be found to reach very near the figures stated in my paper.

Having disposed of this part of the question, the meaning of the phrase, "a narrow gauge is infinitely less costly than a broader one," will be easily understood; but to make it more so I will add (taking the present proportions of dead to paying weight as a "*sine qua non*") that any gauge which shall compel—not permit—a reduction of these quantities, say from 29 to 1 to 15 to 1, and from 7 to 1 to 3 or 4 to 1, must be "infinitely less costly," if taken on this ground alone without reference to first cost of line and rolling stock. Now it is clear that if by the adoption of a narrow gauge (I recommend 3 ft. as the proper gauge for all speeds up to 30 miles an hour) wagons of 1 ton only are sufficient to carry three times the average load now taken in the present wagons, which average 4.25 tons, that a saving must be effected in the cost of haulage in these proportions, and the gauge which does this I think you must admit will be "infinitely less costly," as also that the "dead weight of trains is in proportion to the gauge on which they run," because the gauge compels that wagons shall be in proportion to it. That gauge is the best which gives the required floor area for passengers and merchandise most convenient for working and handling, and with an angle of stability that shall ensure perfect safety at the speed determined for the trains to run with the least amount of dead weight. Every inch you add to the gauge beyond that which secures this you add materially to the dead weight, or in the words of the paper, "the ton of material placed in this form is stronger, and produces better results than placed on a wider basis," *i. e.* wider gauge, to get the same platform area. The lighter the wagon really consistent with the duty it has to perform, the less the dead weight *must be* and the less the opportunity that management has, however bad it may be, of creating dead weight by running partially filled wagons in trains.

Were it not that I have pointed out the limits of the narrow gauge, your joke about the velocipede might tell. I have stated that the Festiniog line, though performing wonders, is too narrow, and that 3 ft. is the gauge where passengers and general merchandise have to be carried, and 2 ft. 6 in. for mineral traffic only. You evidently do not understand the position that a wagon or truck takes on a curve, or you would not have committed the blunder you have in your foot-note respecting the passage of curves on broad gauge. The next time you are out on a road get a wagon or truck pulled on a curve, and you will find that one of the *leading wheel* flanges will *rub hard* against the edge of the OUTER rail, whilst one of the *trailing wheel* flanges will *rub hard* against the edge of the INNER rail. Reckon from this how much assistance "coning the tread of the wheels" will give you in passing sharp curves. The remainder of your article is generally replied to in the above. You have managed to write three and a half columns which could have been better occupied with anything else, seeing that by a like investigation in the first instance, a little examination of the foundation of your argument, you would have ascertained that it was only sand, and that the three and a half columns could not be supported on it.

I concede that your lines are better worked, cheaper worked, and better dividend-paying than ours are. I concede, also, that there is much to be learned from an examination of things as they are with you—very much that would improve us. I concede that the highest praise is due to your engineers, who have seen the enormous advantages given by the bogie system and have stuck to it,—all these I concede with much pleasure; but one thing I cannot concede, and that is that you understand the subject you have undertaken to write about. I am, sir, your obedient servant,

ROBT. F. FAIRLIE.

Railway Gauges.

Upon a first consideration it appears somewhat strange, that after so many years of varied experience in railway construction, the gauge question should yet remain unsettled, and that so many erroneous ideas should exist upon the subject, so many false notions as to relative cost, as to relative capacity, and as to relative speed. Yet it is so. "The battle of the gauges" almost twenty years since was fought upon a very broad platform. It was then the question between Brunel's magnificent gauge and the more moderate gauge of less monumental engineers. Yet even then none contemplated anything less than the narrower width, and later on, when Mr. Simms recommended the gauge that was afterwards adopted in India, he was influenced by a wish to make a compromise between the doctrines of the two schools. Similar to the arguments advanced then, and much as the want of absolute knowledge shown then, is the want of absolute knowledge shown now. There are but very few who have had practical experience of the cost, the facilities for working, and the capacities of the 3 ft. 6 in. gauge, and none who have had any experience worth recording about a 2 ft. 9 in. gauge. Yet it is from these two widths, or something between these two widths, that the Indian Government has to make its selection, in deciding upon the large secondary system of railways that have to be commenced, and that immediately, if India is to have a fair chance given to her for development during the next twenty years.

It is freely admitted now, that the costly policy advocated by Mr. Simms, and endorsed by the East India Company, is a failure; it is freely admitted that India cannot afford to extend her railway system upon the existing plans, except so far as feebly and slowly throwing out short branches, or extending its trunk lines here and there. It is freely admitted that a great railway system in India is impossible, if some total change is not effected, which shall, with an outlay within her means, give her sufficient accommodation, neither more nor less than she requires. It is just this "neither more nor less" that is the troubled question. It involves many problems. Political necessities and commercial necessities, the probabilities of future development, the chances of sudden calls upon it, for the putting forth of its full capacity; the probabilities of comparative stagnation of business during certain seasons. But two gauges are admissible, the existing one, all too wide, with its narrow rolling stock, still too large for the demands upon it, and the gauge yet to be decided on, one that shall be able to accommodate the maximum traffic with the minimum outlay, at once the most efficient and the most economical.

In deciding this question of the narrow gauge as between 2 ft. 9 in., and 3 ft. 6 in., there are three great questions to be considered; first, cost; second, capacity; third, speed. The first is connected almost entirely with the construction of the road, the second and third have to do with the rolling stock principally.

So as regards cost. The advocates of the wide, and those of the narrow gauges propounded until recently, and some do even now—the one, that the reduction in the cost of a narrow-gauge line was only as much as was represented by the reduction of width between the rails; the other, that the difference in cost varied in direct proportion to the gauge. Collateral to these were the respective convictions—on the one hand, that in a narrow-gauge line all other elements of expense must remain unaltered; on the other hand, the elements of expense decreased just as the rails approached each other. We believe that these convictions are gradually fading out, and that it is becoming admitted that it is not the *gauge* that rules the cost, but the numerous articles that enter into the whole schedule of a cheap railway bill, of which the gauge is but one. How far, then, does the cost of a cheap narrow-gauge railway compare with that of a broader gauge? The first standards for comparison that present themselves are the ordinary 4 ft, 8 in. and the 3 ft. 6 in. gauges. But to establish a comparison, it is necessary to exclude so many conditions, and to include so many others, that it is difficult to arrive at a conclusion, The experience of few of our engineers help us here; but we are fortunate in possessing the result of the experience of Mr. Carl Pihl, the Government Norwegian railway engineer, who must and will always be remembered and recognized as one of the leaders of railway reform. Those of our readers who care to refer to the numerous communications from Mr. Pihl that have appeared from time to time in these columns, and to the equally numerous articles in which we have availed ourselves of the experience of that gentleman, will agree with us in what we have said, and will be satisfied to take his results without hesitation. In Norway, then, where the 4 ft. 8½ in gauge was established first as the standard of the country, but where the 3 ft, 6 in. is the recognized gauge, we shall find all we require to establish the comparison long ago published. From a careful investigation, Mr. Pihl shows that the saving in the narrower over the broader is about ⅔ of the outlay—a result borne out not only by the cost per mile of lines now built, but by carefully prepared estimates for lines of the two standards running over the same ground. How, then, will the question stand between 3 ft. 6 in. and still narrower widths? We subjoin a careful estimate of cost per mile for lines of varying gauge.

No. I. TABLE OF COMPARATIVE COST PER MILE OF RAILWAYS OF VARYING GAUGE.

Gauge.	Difference in Width of formation.	Formation Width.	Excavation.	Drainage works.	Bridges.	Ballast.	Sleepers.	Permanent Way, 45 lb. rail.	Fencing.	Stations, Workshops, &c.	Contingencies, 20 per cent.	Total.
ft. in.	ft. in.	ft. in.	£	£	£	£	£	£	£	£	£	£
4 8½		15 0	631.9	73.00	405	402.1	217.65	626.8	150	135	526.29	3,157.74
3 6	1 6	13 6	581.9	7.00	383	314.0	171.60	626.8	150	135	486.5	2,918.9
3 0	0 6	13 0	568.7	69.00	375	301.3	155.37	626.8	150	133	476.23	2,8 7.39
2 9	0 6	12 6	555.35	68.00	367.5	294.9	147.64	626.8	150	135	469.03	2,814.94
2 6	0 6	12 0	542.0	67.00	360	288.5	139.92	626.8	150	135	461.810	2,770.06

No. II. TABLE OF DIFFERENCES IN COST ON RAILWAYS OF VARYING GAUGE.

Gauge.	Difference in Width of formation.	Excavation.	Drainage.	Bridges.	Ballast*	Sleepers.	Permanent Way, 45 lb. rail.	Fencing.	Stations, Workshops, &c.	Contingencies, 20 per cent.	Total.
ft. in.	ft. in.	£	£	£	£	£	£	£	£	£	£
4 8½		40.0	3.0	22	88.1	46.65	.....	.....	.....	29.79	239.54
3 6	1 6	13.2	1.0	8	12.7	15.63	.....	.....	.....	10.95	60.81
3 0	0 6	13.35	1.0	7.5	6.4	7.73	.....	.....	.....	7.19	43.15
2 9	0 6	13.35	1.0	7.5	6.4	7.72	.....	.....	.....	7.19	43.15

The above tables are based upon careful and detailed estimates of an existing line, and may be taken to represent a type of a first-class single track railway. It will be seen that in three of the large items, namely, rails, fencing, and stations, the amounts are constant, whilst the other items of cost are reduced in a proportion much more moderate than would be imagined, the total difference between the 3 ft. 6 in. gauge and that of 2 ft. 9 in. being only 104*l.* per mile.

Coming more nearly to the case in point; to the consideration of cost between a gauge of 2 ft. 9 in. and one of 3 ft. 6 in. for the Indian railway system, we have to learn what economy will be effected between the two. To do this properly, we must have recourse to an actual example, to a proposed line in India that has been carefully located, graded, and estimated, having the same weight of permanent way in each case, namely, 42 lb. to the yard. And, first, we will take the cost of the gauge of 5 ft. 6 in. per mile, the assumed formation width being 14 ft.

	£
Earthworks	295.2
Permanent way, 42 lb. per yard, to include fastenings, sleepers, ballast, laying, &c.	2 248.0
Sidings 10 per cent.	224.0
Bridges	812.5
Telegraphs, &c.	157.0
Stations and workshops	625.0
Contingencies and charges	1,034.0
	£5,395.7

We now come to the the 3 ft. 6 in. gauge:

	£
Earthworks, formation, width, 10 ft. 6 in.	258
Permanent way, sleepers, ballast, laying, &c.	1,790
10 per cent for sidings	179
Bridges	729
Telegraph, &c	157
Stations and workshops	558
Contingencies and charges	872
	£4 543

The last summarised estimate will be for the 2 ft. 9 in. gauge:

	£
Earthwork for 9 ft. 6 in. formation	248
Permanent way, sleepers, ballast, laying, &c.	1,690
Sidings 10 per cent.	169
Bridges	729
Telegraph, &c	157
Stations and workshops	558
Contingencies and Charges	845
	£4,396

The respective savings in these three estimates are 824*l.* and 147*l.* per mile.

But it must not be forgotten that if the per centage of sidings allowed in the 3 ft. 6 in. estimate is sufficient, 10 per cent. is too large a proportion to add to the account of the 5 ft. 6 in. gauge, and not enough for that of 2 ft. 9 in. The length of siding room required for the narrower gauge would vary in an inverse ratio to the cross section of the loads carried by the rolling stock, a matter upon which we have dwelt in another column. It is, therefore, being within the mark to add 12½ per cent. instead of 10 per cent. to the siding accommodation of the 2 ft. 9 in. estimate. This would give an additional sum of 42*l.* per mile to be added, reducing the difference of cost to 105*l.* per mile. The outlay for the railway of 2 ft. 9 in. gauge would thus be 97.7 per cent of that with the 3 ft. 6 in. gauge, making a difference of 2.3 per cent. showing a saving suf-

* The ballast is taken at 1 ft. 4 in. deep for the 2 ft. 6 in., 2 ft. 9 in., 3 ft., and 3 ft. 6 in., and 18 in. deep for the 4 ft. 8½ in. gauge.

ficient to construct 165 miles upon the lighter system, out of the 7,000 miles proposed for the secondary *reseau* of India.

We should not omit to state that in framing the foregoing estimates from the more detailed figures of the reports, we have allowed for the same weight of rails in each case. Messrs. Strachey and Dickens, however, propose to employ a 36 lb. rail, which, however suitable it may be for the traffic it is designed for, is nevertheless inadmissible in forming a comparison of cost. The consideration of weight of rail in relation to gauge, we shall discuss on another occasion.

It will be noticed that the differences of cost per mile between the two estimates framed for the Indian railways, and those tabulated above for a line in this country are identical. This exact agreement is, however, merely a coincidence, for the different conditions involved in the construction of various lines, would of necessity produce discrepancies in the comparison of the proportion of cost to gauge, ranging between the conditions of a light surface line, where the difference would be least, and railways running through such country as that of Norway, where Mr. Pihl has found that the cost of 3 ft. 6 in. lines to be only two-thirds of those 4 ft. 8½ in. wide.

We think little more need be added to dispose of the question of economy sought to be effected by the adoption of extremely narrow railways advocated by Colonels Strachey and Dickens. It may be urged that the partial estimates given are insufficient to allow a practical and valuable opinion to be formed. But as these estimates are framed for a proposed railway 480 miles in length, the basis is sufficiently extended to argue fairly upon, and as the figures show that by adopting a width of 2 ft. 9 in. instead of 3 ft. 6 in., a saving sufficient to construct only 11 miles more of line of equal character could be effected, the advocate of this system must abandon the argument of economy and occupy other ground. It is only just to the authors of the report advocating the width of 2 ft. 9 in., that they do not urge emphatically the argument of economy; indeed, they say that however small the difference may be between a railway of a gauge that is enough and a railway on any broader gauge, it is the duty of the government to select the one and avoid the other in making their final selection. But it is exactly in that question of what is enough that we consider Messrs. Dickens and Strachey at fault. The carrying capacity of a railway, and the speed at which trains may be taken upon it, are the measures of its usefulness; and in selecting a gauge the maximum amount of work to be thrown upon it must be considered, not that which it would have to perform under ordinary conditions. The importance of this consideration cannot be too prominently kept in view, and any error of selection committed now would be irreparable, or remedied at best with an enormous outlay. The time may arrive, and in these days no one can forcast events, even in the immediate future, when the safety of India as a British possession may depend upon her railway system. How short-sighted then, would be that policy which should advocate the adoption of a gauge "wide enough" for her requirements, that is, wide enough for the conveyance of the people and the products of sparsely habited districts, through which these lines would pass. Doubtless a 2 ft. 9 in. railway would be enough for such requirements, not only at present but for many years to come; but how in the event of political difficulties? what if the troubles of war broke over the country? Could such a railway as those proposed convey efficiently an army and its arms; could men, and horses, and guns, and all the munitions of war be concentrated by the agency of an iron way 30 in. wide, or at that season of supreme requirement, would not the means be found inadequate, and the consequence of an unwise policy be keenly felt? These are considerations which do not come within the province of this article, which professed to deal simply with the questions of cost; elsewhere we have dwelt upon other points of still greater importance, and shall resume on another occasion a consideration of the other aspects of the subject.—*Engineering.*

Locomotive Improvement.

Every competent engineer, civil or mechanical, will admit that the locomotive engine, approximately perfect as it is, may yet be rendered better. The civil engineer, indeed, demands that it may be made less damaging to his roads, while the locomotive superintendent earnestly desires to effect a saving in fuel and in the cost of repairs. If then it is admitted by both classes of the profession that improvement is desirable, how is it that the improvement is not effected? It cannot be because constructive skill is lacking. The absence of ingenuity cannot be pleaded as an excuse. The true answer is, that the locomotive is daily undergoing small, almost imperceptible, improvements on the one hand, and, on the other, it must be borne in mind that the locomotive is so nearly perfect in its best form, that the task of making it still better without launching out into a course of costly experiments, for which railway companies have no available funds, is extremely difficult of performance. To use an often quoted illustration of the late Dr. Lardner's, imperfections which will ruin a razor are of no account in a carving-knife. It would not be very difficult to make an average carving-knife of good steel as sharp as a razor, but it would be impossible to make any razor as much sharper than the average of razors. If the locomotive were not very good indeed it would be easy to make it better; in the fact that it is very good lies the obstacle in the way of further perfection. It is by no means to be assumed, however, that the obstacle is insurmountable. What can be done in the way of effecting economy of fuel in one engine, men ought to be able to do in another. If we can get a horse-power for the consumption of 1.5 lb. of coal in the case of the marine engine, we ought to do nearly as well in the case of the locomotive. Certain engineers have shown that it is possible to haul enormous loads without so seriously weighting the driving wheels as to compromise the stability of permanent way. All locomotive designers ought to be able to do the same. If they are competent men, and do not do this, then we must assume that some good reasons exist for the fact. Let us see what these reasons may possibly be; and let us also consider for a moment the direction in which the improvement of the locomotive is most likely to be effected and is most desirable.

The subject may be be best dealt with under three heads: Firstly, the locomotive as a steam generator; secondly, the locomotive as a steam user; and thirdly, the locomotive as a vehicle. It is with the last alone that the civil engineer has, strictly speaking, anything to do. It is only as a vehicle that the locomotive destroys permanent way. The question of what it will draw, and the relation which its power of drawing bears to the contour of a line, troubles him but little in determining that contour, because he knows that whatever that contour may be the mechanical engineer is prepared to supply him with engines to work it with regularity and efficiency.

The first question, then, for consideration is the improvement of the locomotive as a steam generator; and with this alone we shall deal at present; to the others we shall refer at no distant day. The is no room to doubt that the very best locomotives are uneconomical steam generators. The rate of evaporation seldom exceeds 7 lb. of water to one ton of coal. In exceptional instances 8lb. or even 9 lb. have been evaporated, or a little more perhaps; but in these cases the boilers have been new, and the surfaces free from deposit. It is unfortunately a condition of the locomotive boiler that the tubes cannot be freed from scales without taking them out; and as it is certain that scale accumulates more or less slowly according to the quality of the water and the care exercised by the drivers, but does still accumulate, the evaporative economical efficiency of every locomotive must fall off year by year, and decrease from what it was at first. Bearing this in mind, it will not, we think, be wrong to assume that the average duty of all the locomotives in England will not greatly, if at all, exceed 6.75 lb. of water fairly evaporated—not primed—into steam. But this is, as we know, far below the efficiency of other types of boiler. It should not be too much to expect an evaporation of 8.5 lb. of water per pound of coal, considering how good the coal is that locomotives usually burn and the skill of the stokers who attend to its consumption. Is it or is it not possible to obtain this result, not in exceptional cases, but in thousands of locomotives, year after year, and in all parts of the United Kingdom? We fear that the answer must be in the negative. If the past teaches any lesson worthy of notice, we are certain that it cannot be effected so long as the existing type of boiler is retained in its absolute integrity. The horizontal tubular, or locomotive boiler, has undergone an enormous number of modifications, but not one real improvement has been effected. The most highly approved locomotive boiler of the present day is identical with those in use in 1840 is every respect save its dimensions, the quality of its workmanship, and a brick arch in the fire-box. Long grates, combustion chambers, and in the best practice mid-feathers, have disappeared from the railway world. We have nothing left but the approximately cubical fire-box, and a greater or smaller number of brass or iron tubes of a greater or lesser length according to circumstances, running straight to the smoke-box through a cylindrical shell. Not one of the innovations on George Stephenson's designs appear to have obtained any substantial footing in modern locomotive practice. We are on these grounds justified in stating that, so long as the modern locomotive boiler is retained, nothing whatever is to be expected in the way of securing a greater economical evaporative efficiency from the fuel used.

The question naturally suggests itself, is it essential that we should continue the use of a boiler admittedly not the most economical? It is not easy to reply to this question, On the one hand it may be urged that it is possible to work locomotive engines with boilers very different indeed in form; while, on the other, we have the practice of the last thirty years, and of the best mechanical engineers who have perhaps ever lived, in favor of the existing boiler. It is, besides, very difficult to design any other boiler which will comply with the requisite conditions. Where else is there a boiler to be found which will supply us with as much heating surface within a given space? Where is there to be found a boiler at once so easy to make, repair, and keep in order, so safe, so strong, and, all things considered, so cheap? Where is the boiler which admits of such an efficient distribution of weight, is so good-looking—and even good looks are worth considering in designing a locomotive—presents so large an area of water surface—essentially the production of dry steam—and is so easy to fire and attend to in every way? We may answer at once that there is not one in existence. But granting this, it must not be forgotten that it may be possible to design boilers which, differing more or less widely in important respects from the existing boiler, and sacrificing certain of its merits, will nevertheless be better in this, that they will prove more economical as far as the consumption of fuel is concerned. Whether such boilers can or cannot be produced remains to be seen; but it is at all events certain that no locomotive engineer can prove that it is impossible to build a very efficient locomotive with, for example, a vertical boiler. Such a boiler would of necessity be as unlike the ordinary locomotive boiler as possible—and it is for that reason we cite it to illustrate our meaning—but this does not prevent its application to the required purpose. The distribution of weight could be effected with ease; the qualities of the locomotive as either a steam user or a vehicle would remain unaffected; the convenience of firing would be the same as now, cost and weight would remain unaltered. Only two really effective arguments can be brought against a vertical locomotive boiler. The first is, that it is impossible to provide sufficient heating surface of the kind in any suitable vertical boiler; the second is that a locomotive with a vertical boiler is opposed to all preconceived notions on the subject of locomotive engines. To which we reply, first, that it is by no means certain that a boiler of the vertical type cannot be devised which will contain as much heating surface, within a shell of given size, as any locomotive boiler; and, secondly, that the mere fact that no other boiler than the existing type has been used hitherto in first-class locomotives is no reason whatever why it should be adhered to till the end of time. The question, in short, narrows itself to this: Is it or is it not desirable that every pound of coal we burn in a locomotive should or should not make more steam than it does? The universal reply will be that it is highly desirable that the utmost possible value should be got out of the coal purchased by railway companies. But it is certain that nothing further is to be expected in this way from the existing locomotive boiler. The best men of the day have worked at it since 1840; that is to say, for thirty years; it is as perfect new as it is possible it can be, and yet it is inferior in evaporative efficiency to a host of other boilers. To assert that any further improvement is to be expected is simply to assert that Mr. Ramsbottom, Mr. Beattie, Mr. Cudworth, Mr. Miller, Mr. Johnson, Mr. Sinclair, Mr. Sturrock, Mr. Martley, Mr. Adams, and hundreds of other engineers both in this country, France, Germany, America, &c., really do not know their business. Under the circumstances we are justified in repeating the assertion that if more steam is to be made per pound of coal burned we must alter the type of boiler.

It will, no doubt, be urged by certain of our readers that this is a most "unpractical" article. We grant that it is unpractical in the sense that it indicates, under certain conditions, the necessity for innovations in ordinary locomotive practice; but we cannot admit that it is unpractical in any other sense. No one who is well up in his subject, can deny that further improvement in the evaporative efficiency of the existing boiler is a thing not to be expected in the face of modern practice, which is reverting as fast as possible to the oldest and simplest type of boiler, as may be proved by an inspection of the latest engines on the Midland, Great Eastern, London, Chatham, & Dover, Great Northern, Great Western, North London, and many other railways. At the same time, greater exertions than ever are being made by locomotive superintendents to cut down coal bills. The question we submit, is, not whether it is right and proper for a journal like this to suggest innovations on existing practice, but whether these changes so suggested are or are not likely to secure the desired end, and comply at the same time with the required conditions. And we desire it to be specially borne in mind that in this article we have done nothing more than enforce on our readers the *fact* that no improvement can be expected in the existing locomotive boiler, while we place before them the *suggestion* that a different type of boiler might be designed—if it be not designed already—which would prove more economical in the consumption of fuel, and equally convenient for locomotive purposes. We shall not so far wrong locomotive superintendents as to believe that they are so wedded to their own practice that they can see nothing worth consideration in the ideas of others, although these ideas may introduce somewhat novel views on the future of the locomotive engine. We do not put forward as certain that a different type of boiler would be better than the existing type, but we think it probable; and it is indisputable that designers of locomotives generally should not be deterred from introducing possible improvements simply because they are essentially different from existing practice.—*The Engineer.*

[*The Engineer* does not seem to know that vertical boilers were used on some of the first locomotives made in this country. They were built about the year 1836, and ten or twelve of them are still running on the Baltimore & Ohio Railroad. Ed. Railroad Gazette.]

—The New York Commercial *Bulletin* says:

"The prospect of erecting an immense grain elevator on the North River front of this city, first noted some weeks in this column, is rapidly approaching a successful consummation, though the parties interested are very chary of information. We learn, however, that a company has been formed, embracing only a few members, but all capitalists of large means and thorough business experience; and that it is their intention to complete the work in hand in a manner calculated to give New York one of the finest, if not the very best, grain elevator in the world. A capacity of two million bushels is calculated upon, and it is hoped to have this work completed in time for next season's crop. A portion of the necessary grounds and water front has already been secured, and the negotiations for the balance are near a successful termination."

—Hon. Byron Kilbourn, who had much to do with planning and securing the construction of the Milwaukee & LaCrosse Railroad, (now a part of the Milwaukee & St. Paul), died on the 16th inst. at Jacksonville, Fla.

—A peculiar feature in each of thirty-three new locomotives built at the Rhode Island works for the Great Western Railway of Canada, is the placing of the bell in front of the engine, with gearing to the driving wheel, so that every revolution rings it.

Railway Expenditure—The Repairs and Renewals of Carriages.

In a former article we pointed out how large were the gross earnings of the locomotive compared with the cost of its running and working. The total gross receipts, amounting to £40,912,534, had been earned at an expenditure on the locomotive of a sum of £5,200,000, or about one-eighth of the amount earned, leaving seven-eighths available for the other charges which have to be defrayed before the dividend is declared for the shareholder. Last week we drew attention to one of the most formidable of these items of outlay in the working of our railways—viz., the permanent way. The expenditure on the road-bed absorbs £1,764,000 of the amount earned. A third item is that to which we propose now to refer, viz., the cost of running and repairing the carriages and wagons, and other parts of the rolling stock of the companies. It amounts to £1,632,600, of which £1,397,000 is due to England and Wales, £192,052 to Scotland, and £42,700 to Ireland. This sum was expended last year in the repairs and renewal of not less than 272,719 vehicles of all kinds, exclusive of engines and tenders, being as near as possible equal to an average outlay upon each vehicle of £6. The distance traveled by these carriages and wagons was 145,202,000 miles, which would give an average of about 2¾d. per mile run. Every mile traveled by the trains in the United Kingdom produces a gross sum of about 5s. 8d. From this has to be deducted 9d. for the locomotive charges, as we showed in our last, about 6½d. for the maintenance of the way, and now we have a trifle under 3d. a mile for the carriages. We thus account for a fraction over 1s. 6d. for each mile of railway run, out of the 6s. of gross receipts.

Considerable attention nas at various times been directed to this item of expenditure, with the view to ascertain whether any and what savings may be effected in it. Mr. Price Williams, in a very elaborate paper on the maintenance and renewals of railway rolling stock, gives some interesting statistics bearing on this department of railway expenditure, and Mr. Robert Fairlie has paid very considerable attention to this branch of the subject. The information given in our half-yearly reports is as a rule very scanty with regard to the outlay upon this portion of the rolling stock. There are still, however, some data by which to estimate the nature and extent of these outgoings. On the Northeastern Railway the number of wagons, for instance, is 17,429. Many of these are what is known as chaldron wagons, and smaller than those in use on other lines. the cost averaged £73 14s. 8d., and the average annual cost of their maintenance and renewal, calculated upon the returns of twelve years, was £4 8s. 4d., or 6.39 per cent. of the total cost, and equivalent to a "money" life of 15.65 years. The calculation given above of the cost per train mile run is one which, founded upon the average of the whole railways of the United Kingdom, cannot of course be made applicable to any railway in particular, each of which has its special circumstances which more or less affect the cost of working and the expense of repairs. As an illustration of the varying conditions of working the railways, we may take the case of the Great Northern and the North London—the former has a proporti n of carriages to mileage of 1.73, while the latter has 9.48. It would therefore be obviously improper to compare the cost per train mile of carriage repairs on lines so thoroughly dissimilar in character and in the conditions of their working. In the one case the average cost per passenger train mile is 1½d., in the other it is more than 2½d. In the case of the Great Northern the average cost per vehicle per annum is £22 24 while on the North London it is £35.-26. In the case of the Manchester & Sheffield it is £20.71, and on the Northeastern £22. On the Great Northern the period of life is estimated at twenty years, on the North London at nine, on the Sheffield at seventeen.

Mr. Harrison, in his paper on the statistics of railway income and expenditure, read at the Institution of Civil Engineers, says :—

"The cost of repairs to passenger carriages is in most cases from 1½d. to 2½d. per train mile. The few instances in which it exceeds this probably admit of explanation by some peculiarity in the traffic. The cost of repairing goods trucks varies very much. In general it is from 2½d. to 3d. per train mile. On several lines this is greatly exceeded, and the maximum reaches 6d. There appear to be two general causes for this result: one, the large proportional stock required for the mileage run in agricultural districts; the other, the large stock needed for mineral, more especially for coal traffic. For this traffic the number of trucks in a train is large; the trucks are heavily laden, and liable to much rough usage. Besides these general causes there is a special one, arising from the circumstance that some companies find a much larger number of trucks in proportion to their traffic than others. This applies both to mineral and merchandise traffic, more especially the former, and it renders any comparison between the results on different lines altogether fallacious. The locomotive charges form a most important item of expenditure, and may be taken generally at from 8d. to 9d. per train mile. These charges are divided under the head of repairs and running expenses. Taking repairs first, the lines southward of London, which are chiefly for passengers, cost the least, and may be put at from 2¼d. to 3d. per train mile. On the lines where the traffic is mixed, but where the mineral traffic is heavy, the cost is greatest, or about 3½d. per train mile. Applying these two extreme experiences to any particular line, it would be possible to determine, approximately, the cost of locomotive repairs, by considering the character of traffic upon it."

It is most important to the interests of railway property to ascertain whether any and what saving may be effected in this department. Carriages and wagons have to perform a certain amount of heavy work; they have to carry loads varrying greatly in weight, and their strength must, of course, be equal to the maximum work which they have to perform. One cannot fail to be struck with the fact that a very large proportion of the work done upon the railways is done by a power greatly in excess of the amount absolutely necessary. The average load, for instance, of the passenger trains on the London & Northwestern is forty persons, or, allowing a fair amount of luggage, about four tons weight, while the engine and tender and carriages necessary for their conveyance weigh little short of 100 tons, or twenty-five times more than the weight of the load carried. This weight, of course, involves a corresponding amount of wear and tear, and thus augments those items of repairs and renewals of rolling stock which absorb so much of the earnings of our railways. Professor Gordon, in a pamphlet on "Railway Economy," published so long ago as 1849, called attention to this important matter as affecting the net earnings of our railways. He say :

"The existing railway machinery will de found to be monstrously disproportionate to the useful effect produced in four-fifths of the number of times that the machine is put in action. And to this waste of power may be most justly attributed much of the present embarrassment of railway companies....Thousands, nay, millions of miles are run by locomotives and carriages on the present system whilst they are performing an amount of transport of passengers preposterously disproportioned to the power and capacity of the trains employed for effecting it."

Mr. Fairlie has put this point forward in a very clear and forcible manner in a contrast which he made between the Metropolitan Railway, where trains weighing 122 tons carry only 4 tons of passengers, or about one ton of paying load to 30 tons of dead weight, and an ordiary omnibus running upon a much less favorable road, carrys 2 tons of passengers while the vehicle weighs only one ton, or, including the horses and every equipment, less than 2 tons.

We are told in many quarters that it is absolutely impossible to reduce the weight of the rolling stocks of our railways; that it is necessary they should be constructed as solidly as they are in order to withstand the shock and concussions to which they are liable, and to obtain the necessary amount of friction on the rails. We are inclined to believe that this is an assertion which has not been put to any practical test by those who make it. But, assuming this to be the case, there is no reason why we should despair of seeing a closer approximation made between the paying and non-paying loads upon our railways, and a consequent diminution in the high percentages of the cost of repairs and renewals which now appear in our usual half-yearly statements of accounts. If the mountain will not come to Mahomet, Mahomet may go to the mountain—if we cannot reduce the weight of our carriages, we can at least do something to attract more passengers to them. We are glad to see that directors and managers of railways are at last beginning to recognize the fact of the almost illimitable power of earnings which they possess in the locomotive, and the duty consequently imposed upon them of endeavoring to provide work for the able, willing horse which they have under their control. A short time sime since the directors of the southern railway proposed a general advance in the rates and fares in connection with a complete amalgamation of the systems. The union of the systems was not obtained, but the fares were raised, and as a consequence, the receipts fell off, and thousands of travelers were driven from the railway to the road by this suicidal policy. A short time since Mr. Parson suggested, with the view of improving the prospects of the Metropolitan Railway, and to make up for his n t being allowed to apply capital in aid of dividends, that the fares should be revised in an upward direction. Fortunately the experience of the Brighton Company, especially in regard to its suburban traffic, had been obtained, and we now see that in the case of the one company the fares have been lowered, and each week shows an increase of more than 50,000 passengers, and in the other an announcement is made of a very considerable reduction of the fares, to take place on the 1st of November.—*London Railway News*,

Erie's Palace Coaches.

About 10 o'clock on Saturday morning, a number of very intelligent looking men were observed acting in a rather mysterious manner in the Erie Railway depot at Long Dock, Jersey City. They entered singly and by couples until they numbered about twenty. On entering each one approached the sentinel stationed at the door through which passengers for the lightning express passed on showing their tickets, and presenting a small circular whispered in his ear. His invariable answer was :

"Not yet, gentlemen; please wait until No 1 goes out."

The lightning train soon steamed from the depot, when the party were accosted by a fine-looking official.

"I presume you are the gentlemen invited to inspect our new palace coaches?"

"You are quite right, sir," replied the tallest and handsomest man in the group. "As for myself, although I am a Western man, having until recently lived in Chicago, I am now settled in the East, and take great interest in railroad matters."

"Well, gentlemen, here are the coaches," remarked the official, halting the party in front of three cars linked together on a side track.

Two of the cars were bright and gorgeous, glistening with a ground work of brown metallic paint, ornamented with gold stripes and letters. In the centre of one car an eagle held a scroll in its beak, on which was inscribed, "Drawing-room coach Morning Star." The other was inscribed, "The Evening Star." The third coach was a dining-room car that had done some service.

"These are the handsomest coaches I ever set eyes upon," said an enthusiastic Jerseyman.

"I have seen much handsomer ones in the West," replied the gentleman from Chicago.

"We will look at the running gear first, gentleman," remarked the good-natured official. "You see there are six wheels at each end of the coaches. They are connected by the strongest and best running gear in the world, and they have new patent axle-boxes; a variety of springs adapt them to every possible curve."

"Our running gear out West rather knocks this, I think," spoke up the prairie stalker.

"Step inside, gents, and examine the interior of the coaches."

The inside woodwork was mainly highly polished black walnut, silver-plated, the upholstery covered with elegant designs of French moquette; the windows of finely-grained plate glass, while numerous mirrors and paintings embellished the sides and ends. The cars are kept at a uniform heat by hot air pipes.

"Observe these medallion panels that form an arch reaching to the top of the cars. You see we have a width of eleven feet, with ten feet clear in the centre," said the official. "By turning these silver ornaments a couch, with tapestry curtains, is prepared for sleeping; and here we have separate private compartments, with passage ways around them."

"They can't compare with our Western cars," broke in the gentleman from Chicago.

"Colonel Fisk is determined, gentlemen," retorted the official, "not to be outdone in his efforts to make the traveling public comfortable: a dozen of these cars are to be completed at an early day. They will cost $26,000 apiece."

"Why, that would put up a brown-stone front, with all the modern improvements," said an astonished Jerseyman.

"Oh, that is nothing to brag of, we have whole trains out West,, costing $50,000 a car," nervously remarking the Illinoisan.

At this juncture, Dan. Cooper, Daniel Boone, of the Erie staff, invited the party into the dining-room car to partake of refreshments.

Toasts were drank, speeches made. Dan. Cooper related his wildcat experience, a Paterson reporter hoped Colonel Fisk would soon run palace-cars to Paterson, the Western man fell into a doze, and on being aroused by the shrill whistle of a locomotive, muttered: "Let me off at Chicago,"—*New York Sun, Nov.* 28.

—The New York *Tribune* says of the new American Steamship Company to be organized at Philadelphia; "The Pennsylvania Railroad Company at a recent meeting offered to subscribe $400,000 to the stock, provided the merchants and citizens would take at least $300,000 additional. It is now arranged to obtain a charter from the State Legislature during this winter's session. The amount of capital stock has been fixed at $700,000, with the privilege of increasing it to $5,000,000. The plans are made for four steamers. It is specified that they are to be built in the United States—of course on the Delaware River. The material will be the best iron. Their dimensions will be 335 feet in length, 28 feet breadth of beam, and to draw 9 feet of water. They will cost $500,000 each.

"By the ownership of $400,000 of stock, the Pennsylvania Railroad will have a controlling power in the organization, and will extend their tracks from the Market and Thirty-first-street depot to the river front at the steamship wharves, thus affording unbroken communication from the vessels to the far West. They also propose to receipt for freight between any of the Western stations, and all places in Europe; and undertake by this combination to underbid all other separate rail and steamship lines. E. C. Knight Esq., a Director of the Pennsylvania Railroad Company, is the chairman of the temporary committee, and the merchants and citizens have been organized into district or trade committees to present the matter to the people and solicit general co-operation. Thus far the enterprise has met with the most cordial reception, and subscriptions for $250,000 have already been reported. It is expected to render the scheme profitable by its own freight and passenger receipts without Government aid."

—The following circular has been issued to freight agents and officers of the trunk lines to the East :

"To all officers and agents: You are hereby directed to put in force on Monday, November 28, the new rates agreed upon this day, we having pledged ourselves that no freight shall pass over our respective roads at less than full tariff rates, and that no inducements shall be offered to shippers, directly or indirectly, either by way of rebate, drawback or issuing of free passes over our own roads or connecting roads. All parties are hereby enjoined to carry out the above agreement in good faith, so that all shippers may be on a perfect equality." Signed by J. Gould, President of Erie Railway; Thomas A. Scott, Vice-President of Pennsylvania Railroad; W. H. Vanderbilt, Vice-President New York & Hudson River Railroad.

—The laborers on the Omaha bridge, numbering about 175 men, struck on the 12th inst. for an advance of wages. It is reported that no delay will be caused, as their places have been readily filled.

General Railroad News.

MECHANICS AND ENGINEERING.

Speed of Railroad Trains.

A correspondent of the *Scientific American* says:

"In the *Scientific American*, of Nov. 26, you give the average speed of the *Limited Mail* from London to Holyhead, at from 40 to 45 miles per hour, and quote that as the extreme speed of railway traveling.

"At this moment I cannot say what is the actual speed of the *Limited Mail*, but I believe it is nearly 60 miles per hour.

"There are two trains each way daily between London and Brighton, running the distance—nearly 60 miles—in sixty minutes. There are three trains each way between London and Grantham, doing the 106 miles in two hours. Thirty-three minutes is the time allowed for fast trains from Hitchin to London—distance 32 miles.

"I have made many journeys between the above-named places in the time I have given."

To this the *Scientific American* replies: "We have ridden on all the principal English railways, and the only time we remember of having gone a mile a minute was on the express train from Glasgow to Liverpool, and for a short time only on a down grade. Whenever it came to the locomotive drawing the train, the speed was much reduced."

Keokuk Bridge.

The stone work of the bridge was completed on the 6th inst. The superstructure is going forward very rapidly. Work has already commenced on the pivot span.

Railroad Sawing Machine.

Messrs. Smith & Proctor, of Faribault, Minn., have invented a wood-sawing machine, designed particularly for railroad work, which is now in operation at the Milwaukee depot in Minneapolis. The *Tribune* of that city says: "It consists of two saws so placed that two cuts can be made at once. The wood is fed to these saws in a similar manner as grain is fed into a threshing machine, and after being sawed is carried away from the saws by an elevator, like the threshed straw. The machinery, which is very simple, is propelled by an eight-horse power engine. The whole apparatus, engine, boiler, saws and elevator, is built upon a platform, and enclosed like a box-car, in convenient compass to be readily loaded upon a flat car, and shipped from station to station. With a little change, trucks can be placed underneath like a pile-driving car, and then it can be moved upon the track as a separate car. The amount of wood which this machine can prepare for an engine is wonderful. In ten hours it can prepare from 90 to 100 cords easily. It requires about nine men to work it, feed and take care of the wood after it is sawed."

Locomotives for Canada.

The Rhode Island Locomotive Works have a contract with the Great Western Railway of Canada to supply that company with thirty-two locomotives. Sixteen have been already shipped, this week seven more were sent, and the remaining nine will follow this month. The engines have cylinders sixteen by twenty-four inches. The driving wheels are five and one-half feet in diameter. The fire boxes are built of steel, and everything about them is composed of the very best material. They have a railing a few inches high around the top of the tender, and the bell, which is on the forward platform, is kept incessantly ringing when the engine is in motion by its being connected with the eccentrics. This arrangement has been perfected to meet a demand for something of this sort, brought into existence by the Canadian laws, which require that bells must be kept constantly ringing, when locomotives are in motion.

Narrow Gauge.

The Lebanon *Courier* say: A number of gentlemen of Reading, Lebanon, Harrisburg and Allentown are making arrangements to build a two-feet six-inch gauge from Allentown *via* Reading and Lebanon to Harrisburg, running along the Tulpehocken and Swatara creeks, for the purpose of carrying local freights and passengers. They purpose using Fairlie locomotives.

Union Pacific Bridge.

The Board of Directors of the Union Pacific Company have passed a resolution declaring their intention to construct a roadway for wagons, foot passengers and cattle in connection with their railroad bridge over the Missouri between Omaha and Council Bluffs providing that those cities will permit them to charge tolls. There seems to be no doubt that this condition will be complied with.

Kansas Pacific Machine Shops.

The Kansas Pacific Railway Company are about building new shops at Bismarck, near Lawrence, after plans made by Major E. D. Meier. The buildings will be all of cut stone and located on sixty acres of land. The main shop will have a front of 200 feet, and a depth of 600 feet. The top, or frame work, will all be of iron. An engine room, 30x60 feet is attached to this building.

The car shop will be of two stories, the first being 80x200 feet, and the second 70x174 feet, having a capacity for 16 passenger or 32 freight cars at one time.

The blacksmith shop is to be 80x288 feet, with an engine house 30x36 feet connected to it.

The round house will be 385 feet in diameter, and 972 feet in circumference, with 48 stalls, for the accommodation of that many locomotives.

The other buildings comprise a paint shop 80x200 feet, a pattern shop 40x50 feet, an iron warehouse 30x50 feet, an oil house 20x20, and an office for the Superintendent and other officers.

Perforared Locomotive Fire-Bars.

The following is a description of an invention recently patented in England by F. Broughton, of Regent's Park:

"This consists, first, in the fire-bars being perforated so as to permit the free passage of air through the bars, by which means they are constantly kept cooled, thereby preventing clinker or dross adhering to the bars, also preventing the burning, wear, and destruction of the bars through heat and affording facility for the proper cleansing of the bars. Secondly, the perforations in the bars being in slanting and opposite directions to each other, the free passage of air through the bars to engines running short journeys is obtained without the engines being turned, and the bars are thus kept constantly cool in whichever direction the engine may be running. Third, in cases where the engines travel a considerable distance and are turned for return journeys engines foremost."

OLD AND NEW ROADS.

Lake Superior & Mississippi.

Mr. Banning, the late President, in presenting his resignation to the directors of the company, said:

"As the road is now fully completed, and the policy of the State and company thoroughly established by the location of the line and terminus of the road at Duluth, I feel that my services are no longer essential to the success of the enterprise, and I am greatly gratified to believe that with intelligent and energetic management in the administration and operation of the road, it will fully realize to the stock and bondholders all the results promised by myself and the western parties associated with me, as the inducement to the eastern capitalists to embark the vast sums they have in in its construction and equipment."

The resignation was accepted in a series of very complimentary resolutions, one of which was:

"We are glad to bear testimony to the great service Mr. Banning has rendered us during the three years we have been connected with him, and in accepting his resignation it is understood that he remains in intimate and confidential relations with the company until June next, thus aiding it in closing up its construction accounts and in preparing for its active business operations after that time."

Decatur & State Line.

Messrs. Snell, Taylor & Co., contractors, together with a number of the Chicago, Rock Island & Pacific Railroad Company, made a proposition to the board of directors of the Decatur company, at a late meeting, to construct the road from Decatur *via* Farmer City, Saybrook, Germantown, and Wilton Center to connect with the Rock Island road at Mokena. The directors, by a tie vote refused to accept the proposition.

Holyoke & Westfield.

Work was begun in Westfield, Mass., on the 10th inst. The contract with the Canal Railroad is for $375,000, of which $175,000 is to be paid in cash by monthly instalments until the road is completed, which are to be issued and guaranteed by the Canal road. The expense incurred for preliminary surveys is assumed by the contractors, who also agree to construct in Holyoke a passenger house 30 by 80 feet, and a freight house 60 by 150 feet, both of brick, with slate roofs.

The land damages are assumed by the Holyoke & Westfield company. Smith & Ripley, of New York, have sub-contracted for all the grading and masonry, which they agree to complete by October, 1871.

Cheyenne, Iron Mountain & Pacific.

Articles of incorporation have been filed with the Secretary of Colorado Territory incorporating the Cheyenne, Iron Mountain & Pacific Railroad to start from Cheyenne and connect with the Helena, Big Horn & Cheyenne Railroad at the northern boundary of Wyoming. General Silas Reed, Surveyor General, was elected President, and Governor J. A. Campbell Vice President. A committee from the Cheyenne Board of Trade has conferred with the above-named officers in regard to the planting of colonies on the line of the road.

The Lawrence Bridge.

Mr. James F. Joy has addressed the following letter in reference to the bridge to Mr. C. C. Morehead of Leavenworth.

"Somebody has sent me, cut from a newspaper, a proposition of the Kansas Pacific road to build the bridge at Lawrence, and make running arrangements with the various roads.

"The proposition strikes me as every way in favor of Leavenworth, and I think if your people are wise they will accept it. I notice it was laid upon the table, to wait the propositions of other parties, and as usual there may be dissensions among your people. This is the real difficulty with Leavenworth. Your people do not work together. It strikes me that no proposition can be made to your people which will secure so many advantages as this. The money value of the stock is of no importance compared with these advantages. Yours truly." J. F. Joy.

Fond du Lac & Sheboygan.

It is reported that the road has been sold to Mr. James F. Joy, and that it is understood that the plan of Mr. Joy is to eventually extend the road to St. Paul, *via* Ripon, to form a connection with the Northern Pacific, and to run a line of steamers across the lake to either Pentwater or Whitehall, to connect with the Detroit, Howell & Lansing Railroad, now in process of construction from Detroit to the east shore of the lake, thus making a short route to the East. It is stated that Mr. Joy has contracted to complete the above named road through Michigan within a year at a cost of three millions of dollars.

Baltimore & Ohio.

The effect of the decision of the court in Baltimore, in the case of the State of Maryland against the Baltimore & Ohio Railroad, to recover the tax on passengers over the Washington branch, is having an immediate effect. The railroad company has ordered a reduction of 20 per cent on the fare between New York and Baltimore. A corresponding reduction has been ordered on fares at all stations of the Washington branch.

Davenport & St. Paul.

The line of this company, so far as definitely located, runs from Davenport north about ten miles to Mount Joy, bending here to the northwest it crosses the Northwestern's Omaha line at Wheatland, meets the Dubuque & Southwestern at Monticello, and runs upon its grade about twelve miles north to Delhi. Continuing its northwesterly direction, it passes through Fayette to Cresco, in Howard county. There is now in operation the main line from Davenport to Mount Joy, and the Maquoketa branch, from Mount Joy to Maquoketa. The entire line is under contract from Davenport to Fayette, and between Mount Joy and Wyoming, in Jones county, the grading is completed, and nearly ready for the iron.

Bergen Tunnel.

The president of the Delaware, Lackawanna & Western Railroad has issued a time-table in which it is announced that all the trains of that road and its connections will pass through the Bergen Tunnel by the new rail, *via* Paterson and Boonton. In consequence of this, Jay Gould has forwarded to him the following letter:

PRESIDENT'S OFFICE, ERIE BUILDING,
NEW YORK, December 10, 1870.

To Samuel Sloan, Esq., President of the Delaware, Lackawanna & Western Railroad Company, and, Samuel Scoch, Superintendent.

GENTLEMEN:—I am informed that you intend to run passenger trains between Paterson and Hoboken over your Boonton Branch Railroad, commencing on Monday, Dec. 12, 1870. This is a violation not only of your agreement at the time of commencing the tunnel suit, but of the injunction of the Court of Chancery preventing you "from altering in any way, manner, or degree whatever, the status of said Boonton Branch Railroad, or the Morris & Essex Railroad, so far as the same will affect the right of the Erie Railway Company." If you permit this thing to be done, I shall cause application to be made to the Court of Chancery, and have you punished for violating the injunction of the Court.

JAY GOULD, President Erie Railway Company.

Gov. Randolph has been informed of the action of the Delaware, Lackawanna & Western officials. It was announced last Monday that to avoid all danger of annoyance to public travel by any violent conduct on the part of the Erie maagers, the Delaware, Lackawanna & Western Company will postpone opening their passenger travel on the Boonton branch until the order of Judge Beasley concerning their use of the Bergen Tunnel can be authoritatively explained.

Lease of New Jersey Roads.

The managers of the Pennsylvania Central, Camden & Amboy, and New Jersey railroad companies were in conference at Philadelphia for several days last week, arranging the terms of a lease of the two latter roads, with their branches, to the Pennsylvania Company. It was reported in Philadelphia, on Saturday, that the

terms had been fully arranged, and that the "united companies" would lease their property to the Pennsylvrnia Company for a guaranteed dividend of 10 per cent. on their capital stock. The property to be thus transferred is worth at least $40,000.000. The united companies will also lease other local roads spreading over the Southern part of New Jersey, the total value of which is over $20,000,000 more.

Detroit, Howell & Lansing.

The contract for the construction of the entire line of this road has been let to Wells & French, of Chicago. A report that it had been let to Alexander McDonald, of Jackson, Mich., is erroneous.

California & Oregon.

This railroad is completed to Halina, near Tehama, and is progressing northward rapidly.

Albia, Knoxville & Des Moines.

The grading of the first 9 miles, from Albia to Lovilia, was finished last week.

The Pennsylvania and the Camden & Amboy.

The Newark *Advertiser* asserts that there is considerable discussion and gossip pointing to the ultimate lease of the Camden & Amboy Railroad and connections to the Pennsylvania Central. It appears that there is already a contract between these great corporations, which is intended to be perpetual, in reference to their through business. The New Jersey Company some time ago purchased property at Harsimus Cove in Jersey City at a cost of sometbing like $700,000. Shortly afterward the State resolved to assess them $500,000 for the grant of its right to the land under water, while it will cost several millions more to reclaim and adapt it to their great Southern and Western business. This latter being dependent upon the connecting roads beyond this State, the New Jersey Company have not deemed it prudent to undertake the enormous sutlay without some further hold than they now have upon the business of those connecting roads, and their determination was communicated to the managers of the Pennsylvania Central. The ultimatum on the side of the New Jersey Companies thus far appears to be that if the Pennsylvania Central will offer to assume the liabilities and guarantee 10 per cent. interest per annum on the stock of the companies, the officers of the latter will submit the question to their stockholders.

Burlington & Southwestern.

Track laying was stopped for some time, owing to the non-arrival of a Howe truss bridge from Chicago. It arrived on the 13th and is probably now in position, and there will be no more delay until the Des Moines river is reached. The point of junction with the North Missouri road is not yet determined, though, according to the Burlington *Hawkeye*, it is likely to be at Bloomfield. The track will be laid to Farmington early in January. Messrs. Davis & Atlee are the contractors.

Burlington, Cedar Rapids & Minnesota.

The road was completed to West Branch about 8 miles northwest of West Liberty, on the 10th. Track laying is now progressing from Cedar Rapids southward, and from West Branch northward; and there is no reasonable doubt but the entire line to Cedar Falls will be completed before the close of this year.

Worcester & Gardner.

This company will petition the Massachusetts Legislature for an extension of time for the location and construction of their aoad, and for authority to extend it to Winchendon, and to construct a branch to Princeton.

Androscoggin.

Application will be made to the Maine Legislature by the Androscoggin Railroad Company to construct a road from Brunswick to tide water in Bath, and to connect with the Knox & Lincoln Railroad.

European & North American.

Mr. E. L. Burpee, of the European & North American Railroad, and others, will ask the legislature for a charter for a railroad from some point on the line of the European & North American Railway, between the south line of Passadumkeag, and the north line of Winn, westward, through the counties of Penobscot, Piscataquis, Somerset and Franklin, to the west line of the State, at some point between the north line of township No. 3, range 5, and the north branch of Moose river.

Connecticut River.

The company will petition the next legislature for a charter to construct a branch track from some point near Mt. Tom station to Easthampton, with a $75,000 increase of capital stock.

Union Pacific.

The company has closed a contract with Messrs. Edward Creighton, of Ohaha, and C. M. Elleard and Jas. F. Agler, of St. Louis, under the name of the Far West Freight Line, for the business of Northern Utah, Montana, and Idaho. Mr. Creighton is President of the company. This company is to be the only authorized freight line to these points, and will convey freight from St. Louis and Chicago to the points of transfer on the Central Pacific Railroad, without change of cars, and by a daily line of fast mule trains.

Indiana & Illinois Central.

A telegram from Springfield says that the final arrangements for building this railroad, running from Indianapolis, Ind., to Decatur, Ill., have been made, and that the work will be commenced as soon as possible. Much of the line has already been graded.

Brownville & Fort Kearney.

This company has eleven miles of road completed. The officers of the campany are H. C. Lett, President; Ira Moore, Vice-President; J. L. Carson, Treasurer; R. W. Furnas, Secretary. Mr. Lett visits Washington soon to solicit a land grant.

Muscatine, Tipton, Anamosa & Minnesota.

The President of this Iowa company says that he has an offer from responsible parties to take the contract for completing the grading, ironing and equipping of the road within four months after the contract is signed, provided the people along the line will raise $200,000, payable six months after the cars are running from Muscatine to the Northwestern Railroad, thirty-five miles.

Flint & Pere Marquette.

On the 7th inst. the track had reached the 56th mile west of Saginaw River, at a point known as Farwell Station.

Chicago & Southwestern.

A correspondent writes to us from Drakeville, Iowa, fifteen miles beyond Fairfield, that the track was to reach that place by the 19th or 20th. The grading is nearly completed to the Missouri State line, about forty miles distant from Drakeville, and the intention is to have the iron laid to that point by spring.

Intercolonial Railway.

The Commissioners report that they anticipate that the track will by the end of next year be completed for 85 miles in the province of Quebec, 79 miles in New Brunswick, and 73 miles in Nova Scotia. The principal obstacles in the way will be the heavy clay cuttings at Trois Pistoles, the rock cutting at Bic Mountain, the clay cutting at Amherst ridge, and the crossing of a deep gorge in the mountain side. It is hoped by the close of the year to have the entire right of way purchased; the prices paid so far, have been, it is said, very reasonable. Tenders have been asked for steel rails, the delivery of which will commence in the spring.

Springfield & Illinois Southeastern.

On the 15th inst. the last rail was laid between Edgewood and Shawneetown on the Springfield & Illinois Southeastern Railroad. Thus there is now a continuous rail route between Chicago and Shawneetown. The line thus completed was commenced two years ago by the "Illinois Southeastern Railroad Company," which afterwards combined with the Pana & Springfield Company. Cutler, Dodge & Co., the contractors, intend to run two trains daily over the line between Shawneetown and Edgewood after the 1st of January.

Portland & Ogdensburg.

The road was opened, on the 12th inst., to Baldwin, about 30 miles west from Portland.

Pickering Valley Railroad.

This is a branch of the Philadelphia & Reading Railroad, leaving the latter at Phœnixville, 27½ miles northwest of Philadelphia, and following the Pickering and French creeks through a rich iron and agricultural district of Chester county, Pa., for 13 miles. The grading of the road is nearly completed, and the laying of the track from Phœnixville commenced.

Toronto & Muskoka.

The contract for the construction of the first section of this Canadian railroad, which has been located from Barrie to Washago, was let on the 10th inst. This section extends from Barrie to Orillia. The tenders for its costruction were: Ginty & Co., $217,589.82; Jones & Campbell, $218,415; Grant & York, $227,230; F. Shanley, $237,274; Wilson & McGann, $280,800; Kennedy, $371,500; Koyl & Wood, 510,938.60. The contract was awarded to Messrs. John Ginty & Co.

Lafayette, Bloomington & Muncie.

It is reported that work will be begun on the east end of this line very soon.

Rockford, Rock Island & St. Louis.

The Burlington *Hawkeye* reports that an arrangement was made between the above company and the Chicago, Burlington & Quincy, by which the former will use the latter's track between Burlington and Monmouth. It says also that there are to be close working connections between these roads and the Burlington, Cedar Rapids & Minnesota Railroad. It intimates that a project of a connection between the Rockford road and the Toledo, Peoria & Warsaw, which a few months ago was supposed to be agreed upon, is now not at all good, and that the proposed common line from a point a few miles northwest of Bushnell to Burlington has been given up.

Northern Pacific.

On the 1st inst. the Northern Pacific had nearly completed an engine house at its eastern terminus, which is at the junction with the Lake Superior & Mississippi Railroad, near the Dalles of the St. Louis. The engine house is 120x30 feet. At the same place are large coal sheds.

Fairbury, Pontiac & Streator.

This road, which gives an outlet from the Vermillion coal mines to the Toledo, Peoria & Warsaw Railroad, and also forms an extension southeasterly of the Ottawa, Oswego & Fox River Valley Railroad, is all graded, and the piers of the bridge over the Kankakee at Pontiac are constructed. It is now proposed to extend the road southward from Fairbury to Effingham, about 120 miles, dividing the distance between the two lines of the Illinois Central.

Delaware, Lackawanna & Western.

The company has leased for a term of 999 years the property of the Lehigh Coal and Navigation Company, which owns about 8,000 acres of fine coal lands in the Lehigh district, more than 150 miles of first-class locomotive and 30 or 40 of gravity railroad, and a canal some 60 miles long. The railroad connects at Scranton with the Delaware & Hudson and Delaware, Lackawana & Western railroads, and at the other end of its line, Easton, Pa., with the Morris & Essex division of the Delaware, Lackawanna & Western.

Minneapolis & White Bear Lake.

On the 15th inst. the contract was let for the construction of this railroad, which is to connect Minneapolis with the Lake Superior & Mississippi Railroad at White Bear Lake, which is twelve miles north of St. Paul, and is the point of junction of the branch to Stillwater. The contract calls for the completion of the road, which will be about fifteen miles long, by the 1st of June.

Leavenworth, Lawrence & Galveston.

A mass meeting of the people of Leavenworth lately adopted resolutions, which are endorsed by the Common Council of that city, to the effect that they consider the provisions of the bill now pending in Congress intended to relieve the above company from the necessity of completing its line of road from Lawrence to Fort Leavenworth, before receiving titles to lands as specified in the act of Congress of March 3d, 1863, are detrimental to their interests and an outrage to their rights; requesting the senators and representatives of the State of Kansas to do their best to defeat the bill; and affirming that the completion of the road is a "financial necessity" to the Government, for the distribution of troops from Fort Leavenworth.

As there is already a railroad in operation between Leavenworth and Lawrence (the property of the Kansas Pacific), it is easy to see why the Leavenworth, Lawrence & Galveston Company is unwilling to construct another.

Chesapeake & Ohio.

Mr. C. P. Huntington, President of the company, has prepared his first report to the stockholders of the company. It states that the road from the Falls of Kanawha to the mouth of the Guyandotte, on the Ohio River, has been placed under contract, and the balance of the road will be soon given out, so as to ensure its completion and have it in running order during the summer of 1872. The total length of the road west of Covington is 222.43 miles, of which only 22 miles are in operation. In other words, about 200 miles are to be constructed within two years from the date when work was commenced. The maximum grade of the road ascending Westward across the Allegheny range is 60 feet per mile for about ten miles. The descending grade is about 30 feet per mile. The maximum grade on other portions of the road is 30 feet per mile, the minimum grade 15 feet. Speaking of the prospects of the road Mr. Huntington says: "The vast, undeveloped mineral and agricultural resources along its entire line, give assurance that the local business of the road will soon yield ample returns for all that it has cost. Add to this the almost unlimited business that will naturally become tributary to it from beyond its line, and it requires no extraordinary sagacity to perceive that the Chesapeake & Ohio Railroad will, at no distant day, assume a position second to none of the great trunk lines leading Westward from the Atlantic coast."

Marietta & Pittsburgh.

The progress of this road is thus described in the annual report made on the 14th inst.:

"There has been expended in the construction of the road, between Marietta and Caldwell, for rights of way, grading and superstructures and general expenses, the

total sum of $115,897.31. Nine tenths of the grading and bridging of road for this distance, over 34 miles, has been accomplished. The cross ties are nearly all out and delivered along the line. Six miles of rails, commencing at the Ohio river within the corporate limits of Marietta, have been laid down. One new locomotive, the 'Marietta,' and sufficient platform cars for construction purposes, have been procured and placed upon the road."

Most of the line now graded is to be open for business early next season. The iron laid weighs 45 lbs. to the yard.

Chicago & Southwestern.

The Leavenworth *Bulletin* of the 17th says:

"The Chicago & Southwestern Railroad folks in this city have received a letter from the headquarters of the road, in Chicago, saying that a report of our present railroad situation and imbroglio had been laid before Mr. Tracy, President of the Chicago & Rock Island Company, and he has stated that he agreed to make this the terminus of the Chicago & Southwestern upon the express understanding with the people of Leavenworth that he should have direct and uninterrupted connection at this point with the Kansas Pacific, Missouri Pacific, and the Leavenworth, Lawrence & Galveston roads, more especially the latter, whereby he would have a direct and uninterrupted line from Chicago to the Gulf; and that, if the present proposition to repeal the right of way of the Leavenworth, Atchison & Northwestern road through the city shall be carried out, thereby destroying the uninterrupted connection which we have promised to give him, he will consider it a direct and positive violation of agreement on the part of the city, which will absolve him at once from all obligation to make this his terminus, and compel him, at the same time, to go with his main line to some other point, where he can make direct connections with the West and South. Atchison, we presume, is the point meant, for there he can connect with the Atchison, Topeka & Santa Fe road. He says no through line can afford to be subjected to the annoyance, delay and expense of transferring and changing cars."

St. Louis & Iron Mountain.

The grading of the first twenty-two miles of the Arkansas branch, running south from Pilot Knob to a place called Annapolis, or Big Creek, being completed, another division of twenty-three miles further south has been put under contract, to be finished early in the spring. A considerable grading has also been completed in Butler county. The iron sufficient for forty-five miles of this extension is now arriving, and tracklaying is now going forward. One hundred new box cars are building for Southern traffic.

Kansas Pacific.

This railroad was obstructed several days this week by a snow storm, one of the heaviest known in Colorado. Drifts fifteen feet deep were encountered. The road was open from Wallace eastward.

South Georgia & Florida.

The Flint River bridge is completed and the first passenger train passed over it on the 15th instant. It consists of two spans of 150 feet each, and was planned by the Chief Engineer of the company, Major J. A. Maxwell, and built by Messrs. Geo. Smith & Co., contractors. The building of this bridge completes the company's line from Albany south to Thomasville, in Southern Georgia, where connection is made with the Atlantic & Gulf road for Savannah.

Cincinnati, Hamilton & Dayton.

There are reports in Cincinnati that the Pennsylvania is negotiating for the lease of the above road. This road does not fit well into the rest of the Pennsylvania's system. It would complete a route from Chicago, it is true, but this can be done by acquiring the Cincinnati, Richmond & Chicago road, which is not half so long and gives a shorter line. But by controlling the Hamilton & Dayton road the Pennsylvania could fence all the other eastern lines out of Cincinnati. The natural consequence would be the immediate construction of a new line from Dayton or Springfield to Cincinnati, and then the last state of the Cincinnati, Hamilton & Dayton would be worse than the first.

Peoria & Rock Island.

The company has laid eight miles of track from Peoria westward and has iron enough to lay 17 miles more and is receiving iron faster than it can be laid. One of the coldest days of last week 2,000 feet of iron were laid. Tracklaying is progressing as fast as the weather will permit, and as the road bed is all ready and the iron all secured, it is believed that the entire line will be completed by the 1st of May.

Madison & Portage.

This new railroad was completed the other day from Portage to within a mile of the city of Madison, when the supply of iron gave out, and no more could be obtained without advancing the money, which the company could not command. An appeal was made to the city of Madison to advance the money needed, which was met favorably by the Common Council. It has voted in favor of raising $25,000 for the company, subject to an authorization by the Legislature and a vote of the people.

The Cincinnati Railroad Bridge.

It is rumored that the board of officers that lately inspected the plans of the new bridge at Cincinnati, has taken ground that the bridge. as planned, does not conform to the law, and recommends that the needed change be insisted on. There seems to be a misunderstanding at Pittsburgh regarding the dimensions of the bridge of the Cincinnati Southern Railway, as provided for in the bill of Mr. Stevenson. The following is the proviso of the bill regarding the matter:

Provided, That the bridge across the Ohio river shall have an unbroken or continuous span across the main low-water channel of an elevation not less than ninety feet above low-water mark, nor less than forty feet above the extreme high-water mark, as understood at the point of location, measuring for such elevation to the bottom chord of the bridge, and all spans other than the one over the main low-water channel shall be at least 250 feet in length in the clear, and the span covering the main low-water channel shall be of such length as to leave at least 500 feet for unobstructed passage-way for navigation at all stages.

ELECTIONS AND APPOINTMENTS.

—Mr. Banning, President, and Mr. Lamborn, Secretary of the Lake Superior & Mississippi Railroad Company lately resigned, and the following directors and officers have since been elected: Frank H. Clarke, President; Samuel L. Felton, Vice-President; Charles Eliot Furness, Secretary and Treasurer; Wm. G. Moorehead and J. Clarke, Finance Committee; W. W. Hungerford, General Superintendent. Directors:—John Edgar Thompson, Samuel M. Felton, Wm. G. Moorehead, Isaac Hinckley, Frank H. Clarke, J. Hinckley Clarke, Geo. C. Thomas, Jay Cooke, Jr., Robert H. Lamborn, Wm. L. Banning, James Smith, Jr., Charles H. Graves.

—The directors of the Michigan Midland Company met at Lansing on the 9th instant, and elected John E. Kitton, President, and Uriah Hayden, Secretary, both of St. Clair; the Hon. N. G. Isbell, of Lansing, Treasurer; and John G. DaCosta, Jr., Chief Engineer. A resolution was unanimously adopted approving an early consolidation of the Michigan Midland with the the Peninsular Railway Company, and Messrs. Kitton, Trusdail and Agens were appointed a committee on the part of the Michigan Midland to confer with Mr. Dibble, President of the Peninsular Railway, for the purpose of preparing the agreement for the consolidation of the companies into one corporation.

—The following gentleman have been elected directors of the Toronto & Muskoka Railway for the ensuing year: Messrs. Frank Smith, Anson P. Dodge, John Turner, Robert Spratte, Robert Wilkes, W. H. Howland, S. B. Harmon, N. Barnhart, W. D. Ardagh.

—Mr. J. R. Yeilding, of the General Passenger Department of the North Missouri Railroad, has been appointed Western Traveling Agent of the Nashville & Northwestern Railroad. Mr. Yeilding has had much experience, and has extensive acquaintance with ticket men and the ticket business,

—At the annual meeting of the Marietta & Pittsburgh Railroad Company, held in Marietta on the 14th inst., the following directors were elected for the ensuing year: W. P. Cutler, R. R. Dawes, James Dutton, Sam. Shipman, W. P. Richardson, of Washington county, and W. A. Frazier and David McKee, of Noble county. W. P. Cutler was elected President; W. H. Frazier, Vice President; Samuel Shipman, Treasurer, and J. A. Kingsbury, Secretary.

—At a late meeting of the Board of Directors of the Union Pacific Railroad Company the appointment of T. E. Sickles as General Superintendent was confirmed by a unanimous vote.

—The directors of the Lawrence & Paola Railroad Company met at Wellsville, Kansas, on the 9th and organized the company by electing Col. E. Sells, President; Capt. T. A. Shannon, of Paola, Vice President; J. S. Crew, Treasurer; H. J. Canniff, Secretary.

—George Lamb, late chief clerk of the warehouse bureau of the New York Custom House, has been appointed Custom House and Commercial Agent of the Erie Railway, with headquarters at the custom house and at No. 241 Broadway. Mr. Lamb will act as the agent of merchants in the interior to withdraw goods on the export papers, either duty paid or in bond, and forward them as required.

—Henry A. Little, Master Mechanic of the Peoria, Pekin & Jacksonville Railroad, has resigned, and will, it is reported, on the 1st inst., become connected with the Baldwin Locomotive Works. R. F. Hurd, late foreman of the machine shops, has been appointed Master Mechanic in his place.

TRAFFIC AND EARNINGS.

—The traffic receipts of the Great Western of Canada, for the week ending November 25, amounted to £16,413, against £16,842 in the corresponding week of last year, showing a decrease of £429.

—The following is the official statement of the earnings and expenses of the Western Union Telegraph Company for the month of October:

	1869.	1870.
Receipts	$638,926 74	$673,665 95
Expenses	437,533 43	452,250 24
Net profit	$201,393 31	$221,415 71

—The traffic receipts of the European & North American Railway for the month of November, 1870, as compared with the corresponding period of the two former years, were:

	1868.	1869.	1870.
Passengers	$6,579 30	$7,167 08	$7,494 29
Freight	9,886 73	10,553 92	13, 26 14
Mails and sundries	788 45	1,965 06	801 96
Totals	$17,254 18	$18,991 06	$21,352 39

—The receipts of the Great Western Railway for the week ending November 18, 1870, were:

Passengers	$29,005 43
Freight and Live Stock	51,332 68
Mails and sundries	2,229 09
Total receipts for week	$82,567 13
Corresponding week, 1869	81,586 63
Increase	$980 49

For the week ending November 25, 1870, they were:

Passengers	$26,450 31
Freight and Live Stock	51,156 96
Mails and sundries	2,270 53
Total receipts for week	$ 9,877 80
Corresponding week, 1869	81,965 93
Decrease	$2,088 13

—The gross receipts of the Atlantic & Pacific Railroad Company for November were $109,000, and the net raceipts, $52,000, beside £58,000 received from land sales.

—We are informed by Mr. Edward Wilder, Land Commissioner of the Hannibal & St. Joseph Railroad Company, that the sales of the company's railroad land in North Missouri, for the month of November, were to 35 purchases, 1,608 55-100 acres, and 4 town lots, for $720,584.76, or an average of $12.79 per acre.

LOCOMOTIVE STATISTICS.

Michigan Central.

The following is the report of the general average of performance of locomotives on all divisions of the road for the month of November, 1870, as made by A. S. Sweet, Locomotive Superintendent:

Number of freight cars drawn one mile	2,694,695
Equal to cars drawn over entire line	9,483
Number of freight cars drawn one mile in October	2,653,671
Equal to cars drawn over entire line "	9,378
Number of miles run to 1 pint of oil	13.84
" " " 1 cord of wood	32.64
" " " 1 pint of oil in October	13.44
" " " 1 cord of wood "	34.05
Average number of miles run per ton by coal-burning engines	37.37
Average number of miles run to one ton of coal in Oct	29.56
Average of freight trains cars	23.26
Average size of freight trains in October "	22.76
Number of gallons of oil used	2,397¾
Number of cords of wood used	5,549
Number of tons of coal used	2,366
Number of miles run by passenger trains	78,427
" " " freight trains	127,994
" " " miscellaneous trains	18,299
" " " training engines	40,755
Total	265,475

Illinois Central.

The report of S. J. Hayes, Superintendent of Machinery of the Illinois Central Railroad, for the month of October, 1870, affords the following:

Passenger trains	112,475
Freight	307,559
Construction, etc	14,861
Switching	53,063
Total	482,958

The cost per mile run was:

For oil and waste	0.83 cts.
For fuel	7.53 "
For engineers and firemen	5.99 "
For cleaning	1.07 "
For repairs	9.01 "
Total	24.23 cts.

Cost per mile run, in cents:

Passenger engines	16.80 cts.
Freight engines	27.08 "
Construction engines	14.87 "
Switching engines	19.50 "

Average number of miles run to

Pint of oil	13.07
Ton of coal	34.83

One hundred and seventy-nine locomotives made mileage during the month. This report is for 974 miles operated. Nine locomotives have had general, or thorough repairs, and seven are undergoing repairs.

RAILROAD GAZETTE

PUBLISHED EVERY SATURDAY.

CONTENTS.

	Page.
CONTRIBUTIONS.	
Analysis of the Post and Linville Trusses	289
A Letter from Mr. Fairlie	291
SELECTIONS.	
Railway Gauges	292
Locomotive Improvement	292
Railway Expenditure—The Repairs and Renewal of Carriages	294
Erie's Palace Coaches	294
The Case of Snodgrass & Co. against the Pennsylvania Railroad	300
Narrow Gauge Rolling Stock	301
GENERAL RAILROAD NEWS.	
Mechanics and Engineering	295
Old and New Roads	295
Elections and Appointments	297
Locomotive Statistics	297
GENERAL RAILROAD NEWS.	
Traffic and Earnings	297
Miscellaneous	301
EDITORIALS.	
Dead Weight and Paying Load on American Railroads	298
A Great Steamer Company	299
The Reported Lease of the Camden & Amboy	299
The Route of the Northern Pacific	299
The Erie Conference	299
Grain Freights	300
The Baltimore & Ohio and the Project to Pool Earnings	300
Competition with the Grand Trunk	300
CHICAGO RAILROAD NEWS	300
PUBLISHER'S ANNOUNCEMENTS	301

INDEX TO RAILROAD ADVERTISEMENTS.

	Page.		Page.
Chicago, R. I. & Pacific	307	Chicago, Alton & St. Louis	308
Kansas City, St. Joseph & Council Bluffs	309	Chi. Burlington & Quincy	308
Kansas Pacific	307	North Missouri	308
Chicago & Northwestern	307	Pacific of Missouri	308
Pan-Handle	309	Pennsylvania & Ft. Wayne	309
Western Union	307	Erie Railway	309
Milwaukee & St. Paul	307	Illinois Central	310
Hannibal & St. Joseph	308	Michigan Southern	310
		Michigan Central	311

Editorial Announcements.

Correspondence.—We cordially invite the co-operation of the Railroad Public in affording us the material for a thorough and worthy Railroad paper. Railroad news, annual reports, notices of appointments, resignations, etc., and information concerning improvements will be gratefully received. We make it our business to inform the public concerning the progress of new lines, and are always glad to receive news of them.

Inventions.—Those who wish to make their inventions known to railroad men can have them fully described in the RAILROAD GAZETTE, *if not previously published,* FREE OF CHARGE. *They are invited to send us drawings or models and specifications. When engravings are necessary the inventor is expected to furnish his own engravings or to pay for them.*

Articles.—We desire articles relating to railroads, and, if acceptable, will pay liberally for them. Articles concerning railroad management, engineering, rolling stock and machinery, by men practically acquainted with these subjects, are especially desired.

Engineering and Mechanics.—Mr. M. N. Forney, Mechanical Engineer, whose office is at Room 7, No. 72 Broadway, New York, has been engaged as Associate Editor of this journal in charge of these departments. He is also authorized to act as our agent

Change in Rates.—On and after the 1st of January next, the price of subscription will be four dollars per year. Until that time, subscriptions will be received for periods not exceeding one year at the old rate—three dollars per year.

Removal.—About the tenth of January next the office of the Railroad Gazette will be removed to Nos. 110 *and* 112 *Madison Street.*

☞ *Our Prospectus and Business Notices will be found on the last page.*

DEAD WEIGHT AND PAYING LOAD ON AMERICAN RAILROADS.

In another column we give a letter from Mr. Robert Fairlie, in which he makes some comments on the tank locomotive designed by Mr. M. N. Forney, and illustrated in the GAZETTE of November 12. He also reviews our criticism on his paper on the "Gauge for the Railways of the Future" which was read before the British Association at its last meeting. Mr. Forney will speak for himself, if that be necessary. The question of the most economical gauge for railroads is a very important and much-talked-of subject, not only on the other side of the Atlantic but also in this country. A reader of Mr. Fairlie's letter will observe that there is some danger of the discussion degenerating into mere personal dissension, instead of being what it should be—a candid investigation after the truth; therefore we will endeavor to consider Mr. Fairlie's remarks only in their relation to the question at issue, and not as they may refer to us. Those of our readers who are interested in the question of the gauges are doubtless more anxious to know which is the most economical, rather than to have it determined whether Mr. Fairlie or the editor of the GAZETTE understands the subject best. Several companies have been organized in this country to build narrow-gauge roads, and some of them may carry out their plans. It has therefore become a question very great importance, whether the advantages gained from a narrow gauge will compensate for the great inconvenience which must inevitably attend the use of a road with a gauge different from that of any of our existing lines. We admit that, if "on a road of 3-ft. instead of 4-ft. 8½ "in. gauge the goods traffic could be hauled at half the "present cost, with half the motive power," it would be a very strong argument in favor of the narrower road. This question, however, is the point at issue.

Mr. Fairlie says, "I venture to say if you will hon-"estly ascertain the number of passengers and merchan-"dize cars run on any line you like to take (as an ex-"ample) in every train, the number of miles run by every "train, and the number of passengers and tons carried "by each car in every train, that you will find the pro-"portions of 29 to 1 in the one case and 7 to 1 in the "other much nearer the mark than the figures you give." We will do this, but state first that Mr. Fairlie makes no reference anywhere to the weight of engines. We will therefore not include this weight in our figures. In our preceding article we gave the weight of house or covered cars at 20,000 lb. This is higher than the average, and they are the heaviest class of freight cars used. Besides these, all roads employ large numbers of "flat" and "gondola" cars, *i. e.*, cars without roofs. These average about 15,000 lb. in weight and have the same carrying capacity as the others. We have therefore averaged the weights from the numbers of each kind owned by the companies whose figures we quote. The data have been taken from the annual reports of the companies named. They give the number of tons of 2,000 lbs. carried 1 mile and the total mileage of cars. From these it is easy to calculate the average number of tons carried by each car.

NAME OF RAILROAD.	No. of box cars owned by Co.	No. of flat cars owned by Co.	Average weight of cars	Average No. lb. of freight carried by each car	Proportion of dead to paying load
Cleveland & Pittsburgh, Report of 1870	410	1,170	16,297	14,880	1.08 to 1
Chicago, Burlington & Quincy, Report of 1870	2,228	700	18,291	12,260	1.49 to 1
Pittsburgh, Ft. Wayne & Chicago, Report of 1866	1,499	776	18,294	12,220	1.49 to 1
Average	....	....	....	....	1.32 to 1
Pittsburgh, Fort Wayne & Chicago, Passenger traffic, 1865	....	....	....	....	12.4 to 1
do. do. 1866	....	....	....	....	17.2 to 1
Average	....	....	....	....	14.8 to 1

The Pittsburgh, Fort Wayne & Chicago report is the only one we have at hand which gives the mileage of passenger cars. It may be remarked that a large portion of the passengers on that line are through travelers between the East and Chicago, and are carried in sleeping cars which accommodate *only half* the number that an ordinary day car will. The local business of that road is also relatively much smaller than that of many other lines. Notwithstanding these facts, the average is 14.8 to 1, half the proportion given by Mr. Fairlie, which is 29 to 1. We feel confident that the proportion of paying to non-paying load *actually carried* on passenger trains of many railroads in this country, if the weight of locomotives be not included, will not exceed the ratio we named in a preceeding article, which was 8½ to 1. Take as an example the New York & Harlem Railroad. In the report of the State Engineer of New York, the number of miles run by passenger trains is given as 390,827, and the number of miles traveled by passengers, or number of passengers carried one mile, as 27,953,142. Dividing the latter number by the former, we have 71.5 as the average number of passengers per train, who will weigh —counting 140 lbs. each—10,010 lbs. In the same report the average weight of passenger trains exclusive of passengers and baggage is given as 210,000 lbs. After deducting 100,000 lbs. for the weight of the locomotive, we have a proportion of dead to paying weight of 10 to 1.

From these figures it will be seen that our American railroads carry "less than 15 to 1 and 3 or 4 to 1 of "dead to paying load," and, therefore, according to Mr. Fairlie's letter, "are *infinitely* less costly" than English roads.

In the paper read before the British Association Mr. Fairlie says, "On railroads of 4 ft. 8½ in. gauge the pro-"portion of dead to paying weight carried is as 29 to 1 "for passengers and 7 to 1 for freight trains, and this "terrible disproportion is probably due to the system "of management pursued, but in a far greater degree "to the gauge. The dead weight of trains conveying "either passengers or goods is in direct pro-"portion to the gauge on which they run, "or in other words, the proportion of non-paying "weight (as far as that is independent of management) "is increased exactly as the rails are farther apart, be-"cause a ton of materials disposed upon a narrow "gauge is stronger, as regards its carrying power, than "the same weight when spread out over a wider basis." It will be observed that there are three distinct statements made here: first that the dead to paying weight is as 29 to 1, and 7 to 1 on 4ft. 8½in. gauge roads, which we think our figures have shown is not the case in this country, but far otherwise; second that "this terrible "disproportion is probably due to the system of man-"agement pursued," which we are willing to admit; and third, that "it is due in a far greater degree to the "gauge." Now if "the disproportion" does not exist on other roads which have a 4ft. 8½in. gauge, how can it be the gauge which causes it? If it does, the disproportion would always exist in the traffic on roads of that width. Mr. Fairlie lays much stress on the fact, that the average load carried is very small, and that a much lighter wagon would carry it, which may be an argument in favor of light wagons, and if light wagons were possible only on narrow-gauge roads, then a reason in favor of the latter; but light cars can be built for 4ft 8½in.-gauge roads and if the character of the traffic required it, obviously they would be more economical than heavier ones. But certainly this is not such a profound truth, as to require a paper to be written on the subject and read before the British Association in order to demonstrate it. To deliver parcels, we take a light express wagon, but we harness four strong horses to a heavy truck when we haul building stone. If there are many light loads to carry, a light wagon is the most economical; but if the average load instead of being one ton is, as we have shown it to be, over 13,000lbs., then a much heavier car will be economical.

Mr. Fairlie says in his letter, "it is clear that if by "the adoption of a narrow gauge, wagons of 1 ton "only are sufficient to carry 3 times the average load "now taken in the present wagons, which average 4.25 "tons, that a saving must be effected in the cost of "haulage in these proportions, and the gauge which "does this I think you must admit will be 'infinitely "less costly,' as also that 'the dead weight of trains is "in proportion to the gauge on which they run', "because the gauge compels that wagons shall be in "proportion to it." We would like Mr. Fairlie to say what charm there is in putting the rails 3 ft. apart which enables him to build his wagons so much lighter than they can be made for a 4 ft. 8½ in. road? If he means to say that the difference of 20½ in. in the length of the car axles and width of "bogie" frames will make his 3 ft. gauge "infinitely less costly than a "broader one," then he is talking—unadvisedly. He seems to lay special stress on the fact that a narrow gauge "*compels* that wagons shall be in proportion to "it." If the virtue consists in the *compulsion*, then an order issued from the board of directors compelling the employes to make lighter cars would have the same effect as the narrow gauge. Why is a gauge which "permits" a reduction in dead weight less economical than one which "compels" it? The economy arises from the reduction and not from the way it is brought about. It is just as possible to make heavy cars for narrow as for wide-gauge roads. In his letter Mr. Fairlie says, "that gauge is best which gives the "required floor area for passengers and merchandise "most convenient for working and handling, and an "angle of stability that shall insure perfect safety at "the speed determined for the trains to run with the "least amount of dead weight. Every inch you add to "the gauge beyond that which secures this, you add "materially to the dead weight, or in the words of the "paper, 'the ton of materials placed in this form is "stronger and produces better results than if placed on "a wider basis, *i. e.*, wider gauge to get the same plat-"form area.'" Now it would be a curious inquiry to ascertain just how much each inch added to a gauge of 3 ft. would increase the weight of cars. If the increase is "in proportion to the gauge," then it would be 57 per cent. But the body of a car need not be any heavier to run on "bogies" of 4 ft. 8½in.-gauge than would be necessary to run on those of 3 ft. gauge, so that obviously the additional width of gauge need not increase the weight of the car body, which is about equal to that of the "bogies,"or one-half the whole weight of the car; therefore the increase would only be one-half of 57, or 28½ per cent. Neither the wheels, the springs, the boxes, the jaws, nor the centre-pins and plates would require to be heavier for a 4 ft. 8½ in. than for a 3 ft. "bogie." Their parts weigh, roughly estimated, one-half as much as the whole bogie; therefore our percentage of increase can again be reduced one-half, or to 14¼ per cent. Careful analysis, we feel sure, would still further reduce this percentage. There-

fore the difference in weight which is attributable to this difference of gauge cannot be *more* than 14¼ per cent., on Mr. Fairlie's own showing. Quoting Mr. Fairlie's language again, he says: "The lighter the "wagon, really consistent with the duty it has to per- "form, the less the dead weight *must be*, and the less "the opportunity that management has, however bad "it may be, of creating dead weight by running par- "tially filled wagons in trains." If by bad management, dead weight is created by running partially filled wagons in trains, it would seem to be a reason for improving the management, and not for narrowing the gauge. Neither do we see why light wagons would be any less likely to be run partially filled than heavy ones, unless the size of the former should be accurately gauged to the amount of freight to be shipped from each station.

In our criticism of Mr. Fairlie's paper we asked him the question "if the proportion of non-paying to pay- "ing weight is increased exactly—or in direct propor- "tion—as the rails are further apart, what amount of "dead weight would there be if the cars run on a "single rail, like a velocipede, as has been proposed." This he has chosen to call a joke. It is hard to defend reasoning which, when carried to its ultimate consequences, appears absurd even to its author. The idea which we had in mind when we asked the question was to call attention to the fact that within certain limits the distance apart of the rails is only a very small element in increasing the weight of the cars, and that it disappears altogether when the rails meet each other. What the ratio of increase is, as the rails separate, we are not now able to say, but that it is not an arithmetical proportion is clear.

Mr. Fairlie also charges us with a blunder, in a footnote which has reference to the effect of the coning of wheels. He says: "You evidently do not undestand "the position that a wagon or truck takes on a curve, "or you would not," etc. * * "The next time you "are out on a road, get a wagon or a truck pulled on a "curve, and you will find that one of the *leading-wheel* "flanges will *rub hard* against the edge of the OUTER "rail, whilst one of the *trailing-wheel* flanges will *rub* "*hard* against the edge of the INNER rail." Certainly we are obliged to Mr. Fairlie for this elementary lesson, but we take the liberty of saying that the wheels will do no such thing. It has never been our privilege to see English "trucks" or "wagons," but we know that neither our cars nor our engines do as Mr. Fairlie says. Instead of that, every flange on the outside of the curve bears hard against the outside rail, and every flange on the inside of the curve will stand as far off as the width of the track will permit. The only exception to this rule is the front driving wheels of one of our American "bogie" locomotives, and this for the obvious reason that the wheels stand in the line of a chord of an arc. As an illustration of the truth of what we say, we wish it was possible for Mr. Fairlie to examine the curve on the Chicago, Burlington & Quincy Railroad track where it joins the Illinois Central in Chicago. The two tracks are united by a curve of about 600 feet radius, which is laid with steel rails, now down about a year. About eighty-five trains per day pass over it. The head of the outside rail is worn about 1-16 in. narrower than the inner one, while the mud and rust is not rubbed off from the latter. A car run on this curve, and left standing, will have every one of its outside flanges hard against the outer rail, and every one of those on the inside of the curve will stand about one inch from the inner rail.

Mr. Fairlie's reasoning can be summed up as follows:

"The dead weight of trains is in direct proportion to the gauge on which they run," because,

1st. "A ton of materials disposed upon a narrow gauge is stronger as regards its carrying power than the same weight when spread out over a wider basis."

2d. Because "the lighter the wagon the less the opportunity that management has, however bad it may be, of creating dead weight by running partially filled wagons in trains."

We have shown that the difference in weight attributable to the gauge between the cars for a 3 ft., and those for a 4 ft. 8½ in. gauge, cannot be over 14¼ per cent., and our figures prove conclusively that, so far as the amount of dead weight carried is a question of management, that it is possible for an ordinary 4 ft. 8½ in. gauge road to do even better than what Mr. Fairlie claims can be done with a 3 ft. gauge.

We do not desire in any way to treat this question as one inviting comparisons between English and American engineering skill. In the name of human progress and civilization let us put aside all small, personal or national issues, and be ready to learn or to teach on either side of the Atlantic according to the kind and measure of our ignorance or knowledge.

A GREAT STEAMER COMPANY.

The Peninsular & Oriental Steam Navigation Company has lately made its thirtieth annual report. It is noticeable that the total assets of this great corporation, recognized as the greatest of steamer companies, amount only to about $20,000,000, which is less than the capital of most American railroad companies owning 500 miles of road, and less than that of many English companies with less than 200 miles of railroad. This illustrates at once the great advantage of water routes, where capital has to supply only the vehicles and not the way. The Peninsular & Oriental Company provides transportation lines which aggregate not far from 20,000 miles, yet we see that they require comparatively a small capital for that purpose. Its fleet consists of thirty-nine screw and four paddle steamers of tonnage varying from 675 to 3,648 tons; twelve steam tugs; and eight transport, store and coal ships, of from 160 to 1,800 tons burthen. It is constructing in addition to its present stock five new screw steamers, four of which will measure 3,329 tons and the fifth 2,859 tons. Ten of its steamers are in the Mediterranean service (Southampton and Marseilles to Alexandria); twenty on the Calcutta and Suez, Bombay and Suez, and Bombay and China lines; three on the Ceylon and Sidney line; and ten on the Hongkong and Shanghai, Hongkong and Japan, and China coast lines.

The receipts of the company for the year ending September 30, 1870, were (counting $5 to the pound) $11,585,000, or three-fifths of the entire capital, and the expenditures, including reserves for insurance, repairs and renewals, were $10,872,365, which is very nearly 94 per cent. of the receipts. So that it is easy to see that a slight fluctuation in business or some not extraordinary misfortune might have left the company without any surplus. This is probable enough with a small company, whose profits are very likely to be fluctuating; and it is one of the advantages of a great steamer company that its losses are likely to be more evenly distributed, while its business can be conducted with an economy utterly impossible for a line of half-a-dozen vessels operating in distant waters. The Peninsular & Oriental owns transports, tugs, docks, and the appliances for supplying and repairing, the cost of which, if hired, would greatly increase its expenses. As it is, its net earnings were sufficient during the year to provide for dividends amounting altogether to 7 per cent.

This company receives from the British Government £450,000 per year for carrying mails, which formerly it took on board at Marseilles. Since its interruption of communications across France these mails have been transmitted by rail to Brindisi, in Southern Italy, and thence by Italian steamers to Alexandria. The Peninsular & Oriental, however, will soon touch at Brindisi and resume the transportation of the mails across the Mediterranean.

During the last six months reported, four of the company's steamers passed through the Suez Canal, and at the time the report was made one was on the way from Japan to Europe with a cargo of silk-worms' eggs, intending to pass through the canal to avoid a transfer of this delicate freight. The mails still pass by way of the Alexandria & Suez Railroad, and the company will not ask permission to take mails by way of the canal, so that it may dispatch its steamers directly from Marseilles or Southampton to India, until the canal is in such condition that its large steamers can make the passage from twenty to twenty-four hours.

It is very much to be desired that we should maintain several lines in the Pacific ocean, and we have little doubt that the time will come when such lines will be established. But there are obstacles in the way other than those relating to the construction or purchase of vessels under our present laws. One of the chief of these is the fact that English capitalists are satisfied with a low interest, and that they are absolutely free to establish lines on the high seas wherever they may please. But the important thing for America is that the lines be established, and it is of very little consequence whether Englishmen or Americans furnish the capital or the vessels or manage the lines, so that they supply the needed facilities for transportation to and from our ports. But whenever and by whomsoever the lines shall be established, it will be well to study the secret of the success of the Peninsular & Oriental Company. If we mistake not, the successful American steamer company of the future must have a large capital, complete appliances, and the most economical administration.

The Reported Lease of the Camden & Amboy.

The report that negotiations have been made for the lease of this company's lines to the Pennsylvania Company is confirmed. The *United States Railroad and Mining Register*, of Philadelphia, which has authoritative information, says that the lease has not been made; that overtures have been made, but that nothing has been agreed upon. But it says also that "the contract "which has been in force between the New Jersey and "the Pennsylvania lines suffices at present to fuse them "practically into one. Whatever may be done will "have for its object to avoid as far as possible a breach "of this contract, by a more convenient statement of "it."

If this lease is consummated, it is understood that an immense outlay will be made at Harsimus Cove, in Jersey City, where the road has access to the deep water of the Hudson opposite New York, and where it may deliver merchandise destined for other ports directly to the ocean vessels. It is probable that Philadelphia will regard with some jealousy any effort by the Pennsylvania Company to add to its facilities for Nrw York business. There might be some reason in this if this road afforded the *only* route to New York; but as it is, merchandise can always find a good route and good rates to New York, and the problem with the Pennsylvania Company is to provide such facilities as will enable it to secure a larger share of the traffic that is sure to go there.

The Route of the Northern Pacific.

The Ontonagon *Miner* affirms that the Northern Pacific Railroad will be valueless to the country unless it is extended along the south shore of Lake Superior eastward. It is not easy to understand why this should be so. From the present eastern terminus of the Northern Pacific it has railroad connections by pretty direct routes to the East and South. If it should construct a line through the Lake Superior country, it would have no eastern outlet by rail, unless one should be constructed hereafter. To reach the East from Mackinaw it will be necessary to run as far south as Port Huron, Detroit or Toledo, the most northerly of which is very little nearer to the air line from Mackinaw to New York than is Chicago to the air line from Duluth to New York. Moreover, by its recent purchase of the St. Paul & Pacific Railroad, the Northern Pacific gains a rail outlet for its business shorter than either a line from Duluth or Mackinaw—practically the shortest possible.

Objections are also made to the route of the North ern Pacific as being too far southward. It is true that the route adopted across Minnesota is not quite direct; but we suppose that if there is to be any object, either to the Government or the company, in the construction of this road, it must be in making accessible large tracts of fertile land. We do not want a railroad across a desert to the Pacific. The road already constructed is abundantly able to transport ten times the through traffic now offered, and no new line will be needed for this business for many years. If the Northern Pacific does not open a new and fertile country, it will be of very little use. It is therefore not only excusable but advisable that it should be so located as to avoid the more barren sections and run through the most fertile districts. It is useless to subsidize and construct a road which will have nothing to carry; and it will be best if the Northern Pacific should be turned somewhat from a direct course in order to reach cultivable lands, even if its excellence as a through line should be somewhat injured thereby.

The Erie Conference.

The meeting of managers of railroad lines between New York and the West was held at Erie Monday, Tuesday and Wednesday of this week. It was understood that an effort would be made to agree upon terms for the division of the receipts of through business among the several lines and the discontinuance of competition and the expenses of soliciting business. The various parties agreed that such a combination was desirable, though it was well known that it would be very difficult to make it in such a way as to satisfy all the parties concerned, provide against its violation, and leave the various companies in just the position in which they now are in case for any reason the lines should resume competition after a few months or years.

Although the proceedings of the meeting were quite harmonious, it appears that after some discussion it was found impracticable to make a combination for the division of receipts. But a uniform tariff of rates was agreed upon, and it was further agreed to maintain this tariff rigidly, and to make no discriminations in favor of any person or firm.

By the tariff adopted, the rates on freight from New York to Chicago will be as follows: First-class, $1.80; second-class, $1.50; third-class, $1.25; fourth-class, 90 cents; sugar, coffee, fish and syrups, 60 cents per hundred. This is about the average winter rate. On eastward bound freight there is an advance of five cents per

hundred on grain in bulk from Chicago to New York, which is thus made five cents higher than fourth-class. There is also a slight advance on cattle from Quincy to New York.

Rates to other competing points are nearly in proportion to those to Chicago.

The advance on grain to New York has taken effect already. The other changes will be made next Monday, we believe.

The railroads which have agreed to this tariff are the New York Central & Hudson River, the Erie Railway, the Pennsylvania Railroad, the Pittsburgh, Fort Wayne & Chicago, the Pittsburgh, Cincinnati & St. Louis, the Lake Shore & Michigan Southern, the Toledo, Wabash & Western, the Cleveland, Columbus, Cincinnati & Indianapolis, the Michigan Central, and the Chicago, Burlington & Quincy.

These roads were represented by their chief managers—often by both President and General Superintendent. Augustus Schell acted as President, and W. P. Shinn, General Freight Agent of the Pittsburgh, Fort Wayne & Chicago Railway, as Secretary.

The result of the conference is said to be very satisfactory to all concerned. There can be no doubt that if it shall succeed in securing the maintenance of uniform, moderate, but remunerative, rates, it will have done a great service to the community, as well as to the railroad companies.

Grain Freights.

Herapath's Railway Journal has heard of a proposition that the Grand Trunk Railway Company carry corn (or grain, as we should say in America) from Chicago to Quebec and Montreal at the rate of one cent per ton per mile. This, the *Journal* says, is equivalent to the very lowest rate at which coal is carried in England, where the working expenses per train mile are only five-eighths of those of the Grand Trunk. It questions whether such a traffic can be conducted at that rate to any advantage, except to Canadian merchants and millers.

The ordinary rate on grain between Chicago and New York (except during the winter months, when it is somewhat higher) is just one cent per ton per mile by the shortest route. This rate is 45 cents per hundred pounds, which is just 900 cents for an American ton of 2,000 pounds, and the distance by the shortest line is 899 miles. Very large quantities of grain are taken by other routes 960 and 980 miles long, and the business is considered somewhat profitable. The Grand Trunk in the summer usually has to carry grain to Boston, by its route 1,174 miles, for 50 cents per hundred pounds, which is very little more than 5-6 of one cent per ton per mile. The present rate of 65 cents per hundred is 1 1-10 cents per ton per mile.

The Grand Trunk is forced to these rates by the competition of the other and shorter lines; it has heretofore maintained higher rates to the Canadian cities because it partially controlled the business to those cities and could graduate its charges to the cost of transportation. Moreover, it hardly seems probable that any considerable traffic could be created by low charges, as Canada purchases chiefly for milling and distilling, we believe, not for consumption or exportation. Moreover, we imagine that it would not be easy to fill cars returning westward from Quebec or Montreal, while freights in this direction are much more easily obtained on the seaboard.

The Baltimore & Ohio and the Project to Pool Earnings.

A report was sent from New York last week to the effect that the Baltimore & Ohio Railroad Company had refused to send a representative to the conference concerning pooling earnings which assembled at Erie last Monday. The company hastened to disclaim all knowledge of and to deny the very foundation for such a report. It had not declined to take part in the conference for the simple reason that it had not been invited so to do, the object of that meeting, apparently, being to make a combination for Chicago and St. Louis business to New York and Boston, and not from Western points generally to the various Atlantic ports. The Baltimore & Ohio has no line between Chicago and New York, although it transports freight between these places. It is not called upon to negotiate concerning a business which it cannot control.

But, we believe we may safely say, the position of the Baltimore & Ohio has had considerable weight with those negotiating for a combination. Although that company has as yet no line to Chicago, it has one virtually completed to Pittsburgh, and an extension to Chicago projected and partly provided for. The prospect that this company will have an independent line to the seaboard and, likely enough, favorable connections with New York, is likely to make men hesitate before they adopt a policy, intended to be permanent, which will take all their agents out of the field and put an end to all efforts to maintain *prestige* and secure favor for particular lines. Should the Baltimore & Ohio enter the field within two years or so, competition, to destroy which the combination was made, would begin again.

Competition with the Grand Trunk.

Herapath's Journal complains that the Government of the Province of Quebec has granted a subsidy to the proposed North Shore Railway, and says that it will be a competitor of the Grand Trunk, which has no traffic to spare.

It is questionable whether the North Shore Railway would not bring the Grand Trunk more traffic than it would take away. The route is to be from Quebec to Montreal along the north side of the St. Lawrence, and from Montreal to Ottawa on the north bank of the Ottawa River. The last-named section would form of itself a very good branch of the Grand Trunk, and the Quebec and Montreal line would be compelled to send all its traffic destined to points west of Montreal by the same road. The river country is better populated than that through which the Grand Trunk runs between Montreal and Quebec, and it may afford a considerable local traffic. As for through business, *Herapath* says: "We have no fear that the new line from Quebec to Montreal and Ottawa will, in a traffic point of view, interfere materially with the Grand Trunk. For the best of all reasons, we believe the competitor will do the Grand Trunk little harm. Between the points the Grand Trunk carries little traffic. There is therefore nothing of importance to take away."

The North Shore Railway may even be profitable, but in order to secure this desirable end it would be better to make the cost less than $100,000 per mile for road and equipment. One-third of that amount would be better and ought to be quite sufficient in a country like Canada, where labor and timber are cheaper than in the United States, and iron very much so.

The Case of Snodgrass & Co. against the Pennsylvania Railroad Company.

A report has been widely circulated that in this case the plaintiff received a verdict of $29,000. This is corrected in the following letter written to the Pittsburgh *Commercial* by C. A. Carpenter, the freight agent at Pittsburgh:

Your Tuesday's edition stated that the referees in the case of Snodgrass & Co. *vs.* Pennsylvania Railroad Company had awarded the plaintiffs one-half their claim, or $29,000. The award was under seal until to-day, and of course the above was unauthorized. The award is for plaintiffs $360, with interest ($156). Total, *five hundred and sixteen dollars.*

Their principal claim of $58,000 for alleged overcharges, was entirely disallowed. Their claim of $2,000 for cattle injured was reduced to $360.

The plaintiffs—residents of Westmoreland county—took a heavy government contract for cattle in 1861. They purchased at various western points, but principally at Chicago, where one of the firm was located. As it required a heavier capital to carry on the business than the firm could conveniently command, they solicited and received from the agent of the Pittsburgh, Fort Wayne & Chicago Railway Company in Chicago heavy advancements of cash to follow as charges, together with the price of feed, bedding, freight, etc., to Harrisburgh. These accumulations were necessarily assumed by our company at Pittsburgh and carried to Harrisburg, where they were paid by consignees, partially under protest. *four years* afterward they brought suit to recover, alleging that no such amounts were due by them, or, if due, this company had no legal right to advance them here, and collect forcibly at Harrisburg. When it is considered that the matter has been in ligation five years, and that this company were required to, and did prepare a statement showing when, where, to whom, and for what purpose every cent of these moneys was paid, and brought some twenty-eight living witnesses, from as many points between St. Louis and Philadelphia, at great labor and cost, on five different occasions, in anticipation of trial, it may be imagined what a bewildering amount of detail our attorneys had to deal with, to say nothing of their legal researches, and conceded that not only our own, but the Pittsburgh, Fort Wayne & Chicago Railway Company, has had a complete vindication. Their claim for lost cattle was so indefinite, and so at variance with custom among drovers, that the proper defence could not be made eight years after the transactions occurred.

—The exports of rails from Belgium declined in August to 7,132 tons, against 19,486 tons in August 1869 The rail exports of the first eight months of this year were 93,889 tons, against 103,746 tons in the corresponding period of 1869. The exports of rails to the Zollverein, France and Spain show a marked increase; those to Russia, the Low Countries, Turkey, Italy, and the United States exhibit a sensible decrease.

—The London *Globe* gives currency to a report that the French Suez Canal will probably be turned into an English joint-stock enterprise, with the Duke of Sutherland as the chairman. The negotiations, it is said, have been carried on for some time, and the immediate obstacle is the detention of M. de Lesseps in Paris.

Chicago Railroad News.

Rockford, Rock Island & St. Louis.

From the time table of this new railroad by which trains have been running since last Sunday, we learn that there are four trains daily between Sterling and East St. Louis, and one train between Beardstown and East St. Louis. A mail train leaves Sterling at 3:25 a. m., connecting there with the express which leaves Chicago on the Northwestern road at 10 o'clock the evening before. This train reaches East St. Louis at 5:58 p. m. The distance from Sterling is 291 miles, and from Chicago 401 miles. An express leaves Sterling at 3:10 p. m., connecting there with the train leaving Chicago at 10:45 a. m., reaches Rock Island at 5:45, Monmouth at 9:06, Bushnell at 10:35, Beardstown at 12:50 a. m., Chapin at 2:03, Whitehall at 3:24, Brighton at 5:07, Alton Junction at 5:45, and East St. Louis at 6:38 a. m. Thus the distance of 291 miles from Sterling to East St. Louis is made in 15½ hours, which shows an average speed of nearly 20 miles an hour. One can go from St. Louis to Chicago by this route in twenty hours. The mail train leaves East St. Louis at 8:23 a. m. and arrives at Sterling at 12:20 a. m. The express leaves East St. Louis at 8:08 p. m. and reaches Sterling at 11:35 a. m. These connect at Sterling with the trains which reach Chicago at 6:15 a. m. and 4:15 p. m. respectively.

The following is a table of the stations on the road and their distances from East St. Louis. From East St. Louis to Alton Junction the trains run over the St. Louis, Alton & Terre Haute Railroad:

Alton Junction	20.6	Bushnell	154.3		
Upper Alton	22.3	Walnut Grove	159.3		
Woods'	25 1	Swan	163.6		
Brighton	33.7	Roseville	169.7		
Piasa	37.8	Lennox	175.7		
Medora	42.1	C. B. & Q. Crossing	181.7		
Kemper	45 2	Monmouth	182 2		
Sheffield	49.8	Spring Grove	188.0		
Greenfield	51.8	Alexandria	194 0		
Wright's	59.6	Rio	2 2.9		
Whitehall	66.9	Am. Cen. Crossing	208.7		
Barrows	71.6	Edwardsville	212.9		
Smithfield	76.2	Lynn	216.3		
Winchester	82.0	Orion	220.5		
Riggston	86.8	Coal Valley	227.0		
Merritt	8 .5	Camden	234 0		
Chapin	92.2	Rock Island	239.0		
Concord	96 3	Moline	242.2		
Arenzville	100.8	W. U. Crossing	246.4		
Hamilton	104 4	Turn Out	248.4		
Sand Pit	106.1	Rock River Junction	255.1		
Beardstown	1 1.0	Joslyn's	258 7		
Frederick	114.9	Hillsdale	263.2		
Browning	120 1	Erie	268.5		
Osceola	124.0	Pratt's	273.2		
Astoria	128.0	Lyndon	277.7		
Vermont	135.3	R. I. Junction	285.8		
Table Grove	1 9.8	Galt	287.6		
Adair	145.1	Sterling	291.0		

The distance from Sterling to Chicago is 110 miles.

The road is operated in two divisions. Assistant Superintendent H. Loosley has charge of that from East St. Louis to Bushnell, 154 miles long, with G. L. Walker as Train Dispatcher; while W. H. Pettibone has charge of the northern division, from Bushnell to Sterling, with E. B. Kendall as Train Dispatcher. Mr. Loosley's headquarters are at Beardstown; Mr. Pettibone's at Rock Island, with the General Superintendent, Mr. E. Sweet, Jr.

Pittsburgh, Fort Wayne & Chicago.

This company brought into the city last Tuursday about four hundred soldiers on their way from New York to the Pacific coast. They went to Omaha by the Burlington route.

Chicago & Alton.

The earnings continue to show a considerable increase over those of last year. For the second week in December the statement is:

1870	$105,820 15
1869	96,796 20
Increase (10½ per cent.)	$10,023

Chicago, Burlington & Quincy.

This company will commence running trains through between Burlington and Quincy next Monday, from Carthage southward passing over the recently completed Quincy & Carthage Railroad. This line is 72 miles long, the new road forming 40 miles of it. We give below the stations and distances on the new road:

Quincy to	miles.
Homer	4½
Ursa	10
Mendon	15
Lorraine	20½
Stillwell	25½
West Point	28
Basco	33
Carthage	40

The Ottawa, Oswego & Fox River Valley Railroad, which this company will operate as soon as it is completed—within a few weeks, at most—has the following stations and distances south of Aurora. The distances are from Chicago. The junction is very near Montgomery station and three miles below Aurora station.

Fox River Junction	41¼
Oswego	44½
Yorkville	50½
Millington	60¾
Sheridan	65½
Serena	70
Indian Creek	73¾
Dayton	77¾
Ottawa	82
S. Ottawa	82¾
Elvira	90¾
Streator	98½

The road crosses the Rock Island road half a mile north of Ottawa.

—In San Francisco, the street cars have a compartment for baggage and dogs.

Narrow Gauge Rolling Stock.

In another article in the present issue we have dealt at some length with the relative costs of construction of railways of 3 ft. 6 in. and 2 ft. 9 in. gauges; and we now propose to consider the carrying capacities and general features of the rolling stock which the two gauges would respectively accommodate. And here we find almost all the advantages on the side of the 3 ft. 6 in. gauge, without, so far as we can see, any corresponding advantages. In fact, it will, we think, be found, on investigation, that not only can the carrying stock for the wider gauge be built with as small a proportion of dead weight to paying load as that for the narrower line; but that in the former case there can be adopted a system of construction which affords far greater durability and facilities for economical maintenance than that which must be resorted to in the case of the 2 ft. 9 in. gauge. As to the further advantage which the 3 ft. 6 in. gauge possesses in affording facilities for the transport of troops and artillery we shall speak presently, and we intend, in the first instance, to confine our attention to such rolling stock as is required for ordinary goods and passenger traffic.

And here it may be advisable that we should state a few facts, bearing upon the question under discussion, which have not yet generally received the attention they deserve. In the first place it has been generally assumed that the width of rolling stock which any line is capable of accommodating with safety may be taken as about twice the gauge, and within the usual limits of gauge there is little reason to find fault with this assumption. But the advocates of the railways of extremely narrow gauge go further than this, and they argue that because in certain instances vehicles of a breadth exceeding twice the gauge have been used successfully on 4 ft. 8½ in. lines, that, therefore, vehicles of proportionate width can be used with equal safety on a line having a gauge of but 2 ft. 9 in., or even less. This assumption, although at first sight a plausible one, is practically errenous. If it were possible to make a line without unequalities, or if the inequalities of the line and the forces tending to produce oscillation could be reduced in the same proportion as the width of the gauge, then the proposition we have referred to would hold good; but these conditions, we need hardly say, are unattainable, and hence the assumption is inaccurate. The narrower the gauge the greater is the angle through which the vehicle is cantered laterally through a certain depression or elevation of one of the rails, and the greater, therefore, is the inequality produced in the loads on the springs on opposite sides, and consequently on the two rails also. In fact, the narrower the gauge the greater the amount of lateral oscillation to which any given inequality in the line will give rise, and this is a point of especial importance in districts where, from the variations of climate or other influences, the permanent way is liable at times to get more or less out of repair. It is not too much to say that the influence of width of rolling stock on its lateral stability has, in but too many cases, been entirely lost sight of by the advocates of lines of very narrow gauge, attention being solely paid to the height of the center of gravity above rail level, This, however, is a subject of which it would be undesirable to enter into a full consideration in an article like the present, and we, therefore, propose to return to it on a future occasion.

Another fallacy upheld by the advocates of very narrow-gauge lines is, that the narrower the gauge the less—almost in an equal degree—is the proportion of dead weight to paying load, whereas both theory and experience go to prove that so long as the amount of accommodation, and the strength to resist hauling and buffing strains are constant the proportion of dead weight to paying load is almost, if not entirely, independent of the gauge. In other words, if the maximum weight of train in which a vehicle is to be used, and the maximum power of engine to the pulling and pushing of which it is to be subjected be fixed, it matters little so far as the proportion of dead weight per ton of goods, or per passenger carried, is concerned, whether the gauge of the line on which the vehicle is to run be 2 ft. 9 in. or 5 ft. 6 in. This, we know, is a statement which many advocates of very narrow gauge lines will be disposed to contradict flatly, yet is a statement which is supported by ample practical evidence. We have before us particulars of the weights and carrying capacities of the Norwegian, Queensland, and other narrow gauge rolling stock, both for passenger and goods traffic, and with scarcely an exception these particulars prove the correctness of the opinion we have just expressed. Even in the case of the extremely narrow Festiniog Railway we find the dead weight of the passenger stock to be greater per passenger carried than many carriages running on the Continent on 4 ft. 8½ in. gauge lines, these latter carriages notwithstanding affording a greater number of cubic feet of capacity for passenger, and being mounted on 40 in. in place of 18 in. wheels. Similar evidence might be adduced concerning the goods carrying stock were it necessary to do so; but we need merely refer to the carriages and wagons in general use on ordinary lines fifteen or eighteen years ago to prove that light stock can be made for the 4 ft. 8½ in., or a wider gauge, if the general nature of the traffic warrants its use.

We are willing to admit, however, that the wider the gauge the larger the carriage or wagon must be, to obtain the best results as regards the proportion of dead weight to paying load, or, to state the fact in other words, if the floor area and carrying capacity of a vehicle be fixed, there is a certain gauge of line for which such a vehicle can be constructed with less dead weight than for any other gauge. If, therefore, the nature of the traffic to be accommodated be such that small loads only can be obtained for the wagons, then it of course follows that small wagons should be employed, and it also follows, equally as a matter of course, that the gauge to be adopted should be such as is most suitable for the economical construction of wagons of that particular size.

So far the matter is straightforward enough; but it occasionally happens that the class of railway which it is desirable to adopt has to be determined, not merely from a consideration of the general nature of the traffic which shall pass over it, but also from a consideration of traffic of an exceptional nature which the line may be called upon to accommodate. This, we consider, is particularly the case with the proposed new Indian railways. Constructed, as it is intended these lines shall be, to develop parts of the country at present furnished with very indifferent means of communication, they would become, in the event of war or internal disturbances, of immense military importance, and we consider it not merely especially desirable, but absolutely essential that they should not be constructed to any gauge which does not afford ample facilities for the transport of troops, artillery, and military supplies. In this respect—as we pointed out in an article which appeared in the number of this journal for the 21st ultimo—the 3 ft. 6 in. possesses immense advantages over the 2 ft. 9 in. gauge, and, in fact, the advocates of the latter gauge have not yet shown how horses can conveniently and safely be conveyed on it at all, unless by the adoption of vehicles of very great weight in proportion to the load carried. So long as the articles to be conveyed are goods which can be divided out into quantities of almost any desired bulk, the question of size of wagon is a secondary one, so long as that size is not so great as to render it necessary to run wagons but partially loaded. With such goods the fact of an additional quantity having to be conveyed by a train merely necessitates the addition of a certain number of wagons, and, so far, trains on a very narrow gauge line may be capable of conveying very large quantities of goods in bulk, so long as sufficient engine power is provided. But when the articles to be transported are *not* goods in bulk, but consist of military appliances, artillery, horses, or other things which must have a certain space afforded them, then the influence of the gauge in limiting the size of the vehicles becomes greatly felt; and if too narrow a gauge be chosen, it is certain that in some cases, not merely important inconvenience, but most disastrous consequences may be the result.

It will be seen from the facts we have stated that the question of the best gauge to adopt in any particular instance is determinable, in a great measure, by the extent of the floor area and carrying capacity which will be required in the rolling stock, and in the case of an extensive system of railways, such as it is proposed to construct in India, the *maximum* floor area and carrying capacity which will be required on any one part of the system has to be taken as the standard of measurement for the whole. The question of what this standard should be in the case of the secondary system of Indian lines is a matter for serious consideration.—*Engineering.*

MISCELLANEOUS.

—The Western Union Telegraph Company have laid a wire from Bangor, Maine, to Mattawamkeag, a distance of sixty-five miles. Mr. T. S. Plaisted, with four climbers, climbed seventeen hundred and sixty-seven poles and put up forty-eight miles of wire in twenty-six and one-half hours. Most of the route was covered with a foot of snow.

—A railroad to connect the North Sea with the Gulf of Bothnia, from the port of Landswall, on the east coast of Sweden to that of Drontheim, in Norway, crossing the great range of mountains which separates Sweden from Norway, is about to be constructed. English capitalists furnish the better part of the means for the Swedish portion which will be about 200 miles long.

—Gilead A. Smith & Co., of London, give the following quotations for December 1:

Rails, Erie section, f. o. b., in Wales, £6 7s 6d@£6 15s per ton; Welch bars, first-class, f. o. b., in Wales, £6 7s 6d@£7. Boiler plates, in London, £9 15s@£10 5s. Pig iron, 46s@51s. Faggot steel, £16@£16 10s. English refined tin, 130s per cwt.; sheet copper, 76s. Quicksilver, $9 9s per bottle of 75 lbs.

—The telegraph reports from Detroit that Francis H. H. Primrose, who pleaded guilty to the charge of embezzling $23,000 from the Grand Trunk Railway Company, was sentenced, on the 17th inst., to three years in the Michigan State Prison. Primrose implicates S. E. Martin, former Division Superintendent of the same road, and charges that Martin received $17,000 of the money. Martin has gone to Canada.

PUBLISHER'S ANNOUNCEMENTS.

Wendell's Self-Oiling Journal Bearings.

These bearings were illustrated in Vol. I., page 145, of the RAILROAD GAZETTE. Since that time a company has been formed for their manufacture and sale. Very important advantages are claimed for it, among which are a saving of one-half of the oil ordinarily used, of three-fourths of the wear of bearings, of all the cotton waste, of all the delays incident to heated journals, and of much power now wasted for want of perfect lubrication. A cut in the advertisement on another page will indicate the method of its operation. A wick through the journal provides a constant and regular supply of oil from a reservoir by capillary attraction.

The bearing has been used and highly approved on the the Pennsylvania Railroad, the West Jersey Railroad, and other lines. Mr. Van Houten, of the Pennsylvania road, says that with one supply of four ounces to each bearing a truck ran 80 miles a day for 50 days without injury.

The company's office is at No. 59 John Street, New York.

CHICAGO & NORTHWESTERN R. W.

Comprising the PRINCIPAL RAILROADS from CHICAGO Directly NORTH NORTH-WEST and WEST.

ALL RAIL TO THE PACIFIC OCEAN!

Great California Line.

TRAINS LEAVE WELLS STREET DEPOT AS FOLLOWS:

8:30 A. M. Cedar Rapids Pass | **10:15 P. M. Night Mail.**
10:45 A. M. Pacific Express. | **10:15 P. M. Rock Island Pass.**
10:45 A. M. Rock Island Exp. | **4:00 P. M. Dixon Passenger.**

For Sterling, Rock Island, Fulton, Clinton, Cedar Rapids, Boone, Denison, Missouri Valley Junction, Sioux City, Council Bluffs and Omaha, there connecting with the

UNION PACIFIC R. R.

For Cheyenne, Denver, Ogden, Salt Lake, the White Pine Silver Mines, Sacramento, San Francisco, and all parts of Nebraska, Colorado, New Mexico, Arizona, Wyoming, Montana, Idaho, Utah, Nevada, and the PACIFIC COAST.

FROM CHICAGO	Hours.	1st Class Fare.	FROM CHICAGO	Days.	1st Class Fare.
To OMAHA,.....	23	$20.00	To SACRAMENTO,.	4½	$118.00
" DENVER,.....	52	70.75	" SAN FRANCISCO,	5	118.00

TRAINS ARRIVE:—Night Mail, 7.00 a. m.; Dixon Passenger, 11.10 a. m.; Pacific Express 4:15 p. m.; Rock Island Express, 4.15 p. m.; Cedar Rapids Passenger, 6:45 p. m.

FREEPORT LINE.

9.00 A. M. & 9.45 P. M. For Belvidere, Rockford, Freeport, Galena, Dunleith, and St. Paul.

4.00 P. M., Rockford Accommodation.
5.30 P. M., Geneva and Elgin Accommodation
6.10 P. M., Lombard Accommodation.
5:50 P. M., Junction Passenger.

TRAINS ARRIVE:—Freeport Passenger, 2:30 a. m., 3:00 p. m.; Rockford Accommodation, 11:10 a. m.; Geneva and Elgin Accommodation, 8:45 a. m.; Junction Passenger, 8:10 a. m.; Lombard Accommodation, 6:50 a. m.

WISCONSIN DIVISION.

☞ Trains leave Depot, cor. West Water and Kinzie Sts., daily, Sundays excepted, as follows:

10.00 A. M. DAY EXPRESS, for Janesville, Monroe, Whitewater, Madison, Prairie du Chien, Watertown, Minnesota Junction, Portage City, Sparta, La Crosse, St. Paul, and ALL POINTS ON THE UPPER MISSISSIPPI RIVER; Ripon, Berlin, Fond du Lac, Oshkosh, Neenah, Appleton, and Green Bay.

3.00 P. M., Janesville Accommodation.

6.00 P. M. NIGHT EXPRESS, for Madison, Prairie du Chien, Watertown, Minnesota Junction, Portage City, Sparta, La Crosse, St. Paul, and ALL POINTS ON THE UPPER MISSISSIPPI RIVER; Ripon, Berlin, Fond du Lac, Oshkosh, Menasha, Appleton, Green Bay, and THE LAKE SUPERIOR COUNTRY.

5.00 P. M., Woodstock Accommodation.
6:20 P. M., Barrington Passenger.

TRAINS ARRIVE:—5:30 a. m., 7:45 a. m., 1 :10 a. m., 1:00 p. m. and 7:15 p. m.

MILWAUKEE DIVISION.

MILWAUKEE MAIL,.....	8:15 A. M.
EXPRESS, (ex. Sun.) Waukegan, Kenosha, Racine and Milwaukee,.....9:45 A. M.	5:00 P. M.
EVANSTON PASSENGER,.....	1:00 P. M.
HIGHLAND PARK PASSENGER,.....	1:15 P. M.
MILWAUKEE ACCOMMODATION, with Sleeping Car attached.....11:00 P. M.	
EVANSTON ACCOMMODATION, (Daily,) from Wisconsin Div. Depot.....	6:15 P. M.
KENOSHA ACCOMMODATION, (Sundays excepted) from Wells St. Depot.....	4:10 P. M.
AFTERNOON PASSENGER, from Milwaukee Div. Depot.....	5:45 P. M.
WAUKEGAN ACCOMMODATION, (except Sundays) from Wells St. Depot.....	5:25 P. M.
WAUKEGAN PASSENGER, (Sundays excepted) from Wells St. Depot.....	5:00 P. M.

TRAINS ARRIVE:—Night Accommodation, with Sleeping Car, 5:00 a. m.; Day Express, 4:10 p. m. Milwaukee Mail, 10:10 a. m.; Afternoon Passenger, 8:00 p. m.; Waukegan Accommodation, 8:2 - a. m.; Kenosha Accommodation, 9:10 a.m.; Evanston Accommodations, 1.40 and 4.00 p. m.; Waukegan Passenger, 7:55 a. m.; Highland Park Passenger, 3.45 p. m.

PULLMAN PALACE CARS ON ALL NIGHT TRAINS.

THROUGH TICKETS Can be purchased at all principal Railroad Offices East and South, and in Chicago at the Southeast corner of Lake and Clark Streets, and at the Passenger Stations as above.

H. P. STANWOOD, Gen. Ticket Agt.
GEO. L. DUNLAP, Gen'l Supt.

Milwaukee & St. Paul R. W.

THE ONLY ALL RAIL LINE TO

ST. PAUL AND MINNEAPOLIS!

AND ALL PORTIONS OF

Wisconsin, Minnesota & Northern Iowa.

PURCHASE TICKETS VIA MILWAUKEE.

Passengers Going via Milwaukee,

Have Choice of Seats in Clean Coaches, and on Night Trains, a full night's rest in Palace Sleeping Cars.

☞ BAGGAGE CHECKED THROUGH BY THIS ROUTE ONLY! ☜

PASSENGERS FROM CHICAGO can obtain these Advantages only by the MILWAUKEE DIVISION of the CHICAGO & NORTHWESTERN R'Y.

SPECIAL NOTICE.—Passengers destined to any place in Wisconsin, Minnesota, or Northern Iowa, either on or off the Lines of this Company, who cannot procure Through Tickets to their destination, should purchase their Tickets **TO MILWAUKEE,** as this is the Great Distributing Point for these States.

A. V. H. CARPENTER, Gen. Pass. Agt. Milwaukee.
S. S. MERRILL, Gen. Manager, Milwaukee.

CHICAGO, ROCK ISLAND & PACIFIC RAILROAD.

☞ THE DIRECT ROUTE FOR

JOLIET, MORRIS, OTTAWA, LASALLE, PERU, HENRY, PEORIA,
Lacon, Geneseo, Moline,

ROCK ISLAND, DAVENPORT,

Muscatine, Washington, Iowa City,
GRINNELL, NEWTON, DES MOINES,

COUNCIL BLUFFS & OMAHA!

CONNECTING WITH TRAINS ON THE UNION PACIFIC RAILROAD, FOR

Cheyenne, Denver, Central City, Ogden, Salt Lake, White Pine, Helena, Sacramento, San Francisco,

And Points in Upper and Lower California; and with Ocean Steamers at San Francisco, for all Points in **China, Japan, Sandwich Islands, Oregon and Alaska.**

☞ TRAINS LEAVE their Splendid new Depot, on VanBuren Street, Chicago, as follows:

	LEAVE.	ARRIVE.
PACIFIC EXPRESS, (Sunday excepted).....	10.00 a. m.	4.15 p. m.
PERU ACCOMMODATION, (Sundays excepted).....	4.30 p. m.	9.45 a. m.
PACIFIC EXPRESS, (Saturdays excepted,).....	10.00 p. m.	[Mon. ex. 7.00 a. m.

ELEGANT PALACE SLEEPING COACHES!

Run Through to Peoria and Council Bluffs, Without Change.

☞ Connections at LA SALLE, with Illinois Central Railroad, North and South; at PEORIA, with Peoria, Pekin & Jacksonville Railroad, for Pekin, Virginia, &c.; at PORT BYRON JUNCTION, for Hampton, LeClaire, and Port Byron; at ROCK ISLAND, with Packets North and South on the Mississippi River.

☞ **For Through Tickets,** and all desired information in regard to Rates, Routes, etc., call at the Company's Offices, No. 37 South Clark Street, Chicago, or 257 Broadway, New York.

A. M. SMITH, Gen. Pass. Agent. **HUGH RIDDLE,** Gen. Supt. **P. A. HALL,** Asst. Gen. Supt.

KANSAS PACIFIC RAILWAY.

Great Smoky Hill Route,

Now Completed and Open for Business Through to

DENVER, COLORADO.

There Connecting with the DENVER PACIFIC RAILROAD for CHEYENNE, forming, in Connection with the UNION and CENTRAL PACIFIC RAILROADS, another ALL-RAIL ROUTE to

CALIFORNIA, NEVADA, UTAH, MONTANA,

WYOMING, COLORADO, &C.

The most available Passenger and Freight Route to Lawrence, Topeka, Junction City, Abilene, Salina, Hays, KIT CARSON, River Bend, DENVER, CHEYENNE, OGDEN, SALT LAKE CITY,

Sacramento, and San Francisco.

☞ Close Connections are made in Union Depots at KANSAS CITY and STATE LINE with Express Trains of the HANNIBAL & ST. JOSEPH, NORTH MISSOURI and MISSOURI PACIFIC RAILROADS.

Southern Overland Passenger and Mail Coaches leave Kit Carson daily for Pueblo, Trinidad, Fort Union, Santa Fe, &c.

Hughes & Co.'s Splendid Concord Coaches leave Denver daily for Central City, Georgetown, &c.

Passenger and Freight Rates always as low and conveniences as ample as by any other Route.

PULLMAN'S PALACE CARS ACCOMPANY NIGHT EXPRESS TRAINS.

Through Tickets can be obtained at all principal ticket offices. Be careful to ask for tickets via Kansas Pacific Railway, "Smoky Hill Route."

5,000,000 Acres of Farming Lands For Sale!

Situated along the line of this Great National Railway. For particulars, address JNO. P. DEVEREUX, Land Commissioner, Lawrence, Kansas.

R. B. GEMMELL, Gen. Freight & Ticket Agt. **A. ANDERSON,** Gen. Supt.

THE ERIE & PACIFIC DISPATCH CO.

Are Authorized Freight Agents.

For information, Contracts, and Bills of Lading, apply at their office, 64 Clark Street, Chicago.

H. H. RAPP, AGT.

Western Union Railroad.

CHICAGO & NORTHWESTERN DEPOT, CHICAGO. | MILWAUKEE & CHICAGO DEPOT, MILWAUKEE.

THE DIRECT ROUTE!

CHICAGO, RACINE & MILWAUKEE,
— TO —
Beloit, Savanna, Clinton, Pt. Byron, Davenport, Mineral Point, Madison, Freeport, Fulton, Lyons, Rock Island, Sabula, Galena, Dubuque, Des Moines, Council Bluffs,

OMAHA, SAN FRANCISCO

AND ALL PRINCIPAL POINTS IN

Southern and Central Wisconsin, Northern Illinois, and Central and Northern Iowa.

FRED. WILD, Gen. Ticket Agent.
D. A. OLIN, Gen. Superintendent.

THE FAVORITE THROUGH PASSENGER ROUTE!

Chicago, Burlington & Quincy
RAILROAD LINE.

3 THROUGH EXPRESS TRAINS DAILY!

FROM CHICAGO	Hours.	1st Class Fare.	FROM CHICAGO	Days.	1st Class Fare.
TO OMAHA, - - -	23	$20.00	TO DENVER, - -	2½	$63.00
" ST. JOSEPH, - -	21	19.50	" SACRAMENTO, -	4½	118.00
" KANSAS CITY, -	22	20.00	" SAN FRANCISCO,	5	118.00

TRAINS LEAVE CHICAGO from the Great Central Depot, foot of Lake Street, as follows:

BURLINGTON, KEOKUK, COUNCIL BLUFFS & OMAHA LINE

7:40 A. M. MAIL AND EXPRESS, (Except Sunday,) stopping at all stations; making close connections at Mendota with Illinois Central for Amboy, Dixon, Freeport, Galena, Dunleith, Dubuque, LaSalle, El Paso, Bloomington, &c.

10:45 A. M. PACIFIC FAST LINE, (Except Sunday,) stopping at Riverside, Hinsdale, Aurora, Leland, Mendota, Princeton, Buda, Kewanee, Galva, Galesburg, and all stations West and South of Galesburg.
☞ ELEGANT DAY COACHES and PULLMAN PALACE DRAWING ROOM CARS are attached to this train daily from Chicago

TO COUNCIL BLUFFS & OMAHA WITHOUT CHANGE!

9.00 P. M. PACIFIC NIGHT EXPRESS, (Daily, except Saturday,) for Burlington, Ottumwa, DesMoines, Nebraska City, Council Bluffs, Omaha, and all points West. Pullman Drawing Room Sleeping Car attached to this Train daily from **Chicago to Burlington,** and Elegant Day Coaches, from **Chicago to Council Bluffs and Omaha, without change!** This is the Route between

CHICAGO, COUNCIL BLUFFS & OMAHA,
—RUNNING THE CELEBRATED—
Pullman Palace Dining Cars!

49 MILES THE SHORTEST ROUTE BETWEEN

Chicago & Keokuk,
And the Only Route Without Ferrying the Mississippi River!

QUINCY, ST. JOSEPH, LEAVENW'TH & KANSAS CITY LINE.

7.40 A. M. MAIL AND EXPRESS (Except Sunday,) stopping at all stations between Chicago and Galesburg; making close connections at Mendota with Illinois Central for Amboy, Dixon, Freeport, Dunleith, Dubuque, La Salle, El Paso, Bloomington, &c.

10:45 A. M. PACIFIC EXPRESS, (Daily, except Sunday,) with ELEGANT DAY COACHES and PULLMAN'S PALACE SLEEPING CARS attached, running through from Chicago to KANSAS CITY, **Without Change!**

9:00 P. M. PACIFIC NIGHT EXPRESS, (Daily,) with **Pullman Palace Drawing Room Sleeping Car** attached running through from Chicago to QUINCY,

Kansas City, Lawrence, Topeka and Denver,
☞ WITHOUT CHANGE! ☜

64 MILES THE SHORTEST AND ONLY ROUTE BETWEEN

Chicago and Kansas City!
WITHOUT CHANGE OF CARS OR FERRY.

115 MILES The Shortest Route bet. Chicago & St. Joseph.

THE SHORTEST, BEST AND QUICKEST ROUTE BETWEEN CHICAGO AND

Atchison, Weston, Leavenworth, Lawrence,

AND ALL POINTS ON THE KANSAS PACIFIC R'Y.

Local Trains Leave { RIVERSIDE & HINSDALE ACCOMMODATION, 7:00 A. M. 1:30 & 6:15 P. M
GALESBURG PASSENGER ..... 3:00 P. M.
MENDOTA PASSENGER ..... 4:15 P. M.
AURORA PASSENGER ..... 5:30 P. M.

Ask for Tickets via Chicago, Burlington & Quincy Railroad, which can be obtained at all principal offices of connecting roads, at Company's office, 63 Clark Street, and at Great Central Depot, Chicago at as low rates as by any other route.

ROB'T HARRIS, Gen'l Superintendent, CHICAGO.
SAM'L POWELL, Gen'l Ticket Agent, CHICAGO.
E. A. PARKER, Gen. West. Pass. Agt., CHICAGO.

THE GREAT THROUGH PASSENGER ROUTE TO KANSAS
IS VIA THE OLD RELIABLE

HANNIBAL & ST. JOSEPH
SHORT LINE.

Crossing the Mississippi at Quincy and the Missouri at Kansas City on New Iron Bridges; running Three Daily Express Trains, Through Cars and Pullman Sleeping Palaces from Chicago & Quincy to St. Joseph & Kansas City.

The Advantages gained by this Line ovar any other Route from Chicago, are:

115 MILES THE SHORTEST!

To St. Joseph, Atchison, Hiawatha, Waterville, Weston, Leavenworth,

64 MILES THE SHORTEST!

To Kansas City, Fort Scott, Lawrence, Ottawa,

Garnett, Iola, Humboldt, Topeka, Burlingame, Emporia, Manhattan, Fort Riley, Junction City, Salina, Ellsworth, Hays, Sheridan, Olathe, Paola, Cherokee Neutral Lands, Baxter Springs, Santa Fe, New Mexico, and all Points on the KANSAS PACIFIC, and MISSOURI RIVER, FT. SCOTT & GULF R. R's, with which we connect at Kansas City Union Depot.

THIS BEING THE SHORTEST LINE AND QUICKEST, is consequently the cheapest; and no one that is posted thinks of taking any other Route from Chicago to reach principal points in

Missouri, Kansas, Indian Territory, or New Mexico.

DAILY OVERLAND STAGES from west end Kansas Pacific Railway, for Pueblo, Santa Fe, Denver, and points in Colorado and New Mexico.

This is also a most desirable Route, via St. Joseph, to Brownsville, Nebraska City, Council Bluffs, and Omaha, connecting with the Union Pacific Railroad for Cheyenne, Denver, Salt Lake, Sacramento, San Francisco, and the Pacific coast.

Through Tickets for Sale at all Ticket Offices. Baggage Checked Through, and Omnibus Transfers and Ferriage avoided.

P. B. GROAT, Gen. Ticket Agent. HANNIBAL, Mo
GEO. H. NETTLETON, Gen. Supt. HANNIBAL, Mo.

Old, Reliable, Air-Line Route!

CHICAGO, ALTON & ST. LOUIS R. R.

SHORTEST, QUICKEST AND ONLY DIRECT ROAD TO

Bloomington, Springfield, Jacksonville, Alton
— AND —
ST. LOUIS!
WITHOUT CHANGE OF CARS.

THE ONLY ROAD MAKING IMMEDIATE CONNECTIONS AT ST. LOUIS WITH MORNING AND EVENING TRAINS

—FOR—

ATCHISON, LEAVENWORTH, KANSAS CITY,

Lawrence, Topeka, Memphis, New Orleans,

And All Points South and Southwest.

☞ TRAINS leave CHICAGO from the West-side Union Depot, near Madison Street Bridge. ☜

	Depart.	Arrive.
EXPRESS MAIL	*9:15 A. M.	*8:05 P. M.
JOLIET ACCOMMODATION	*4:00 P. M.	*9:40 A. M.
NIGHT EXPRESS	†5:30 "	*12:50 P. M.
LIGHTNING EXPRESS	‡9:00 "	*7:30 A. M.

*Sundays excepted.
†Daily; Saturdays it runs to Bloomington only.
‡Saturdays and Sundays excepted. Monday mornings this train runs from Bloomington to St. Louis.

This is the ONLY LINE Between CHICAGO & ST. LOUIS RUNNING

Pullman's Palace Sleeping and Celebrated Dining Cars!

BAGGAGE CHECKED THROUGH.

Through Tickets can be had at the Company's office, No. 55 Dearborn street, Chicago, or at the Depot, corner of West Madison and Canal streets, and at all principal Ticket Offices in the United States and Canada. Rates of Fare and Freights as low as by any other Route.

A. NEWMAN, Gen. Pass. Agent. **J. C. McMULLIN, Gen. Supt.**

North Missouri R. R.
PASSENGERS FOR
KANSAS AND THE WEST,
ARE REMINDED THAT
THE NORTH MISSOURI R. R.
—IS—

11 MILES SHORTER than any other Route!

BETWEEN

St. Louis and Kansas City.

15 Miles Shorter between ST. LOUIS and LEAVENWORTH

— AND —

50 MILES SHORTER TO ST. JOSEPH!
THAN ANY OTHER LINE OUT OF ST. LOUIS.

☞ **Three Through Express Trains Daily!** ☜

Pullman's Celebrated Palace Sleeping Cars on all Night Trains!

☞ **FOR TICKETS,** apply at all Railroad Ticket Offices, and see that you get your Tickets via St. Louis and North Missouri Railroad.

JAMES CHARLTON, Gen. Pass. and Ticket Agent, St. Louis.
W. R. ARTHUR, General Superintendent, St. Louis.

Pacific Railroad of Missouri.

THE MOST DIRECT AND RELIABLE ROUTE FROM ST. LOUIS THROUGH TO

KANSAS CITY, LEAVENWORTH & ATCHISON,

☞ WITHOUT CHANGE OF CARS! ☜

Close Connections at KANSAS CITY with Missouri Valley, Missouri River, Ft. Scott & Gulf, and Kansas Pacific R'ys, for Weston, St. Joseph, Junction City, Fort Scott, Lawrence, Topeka, Sheridan, Denver, Fort Union, Santa Fe, and

ALL POINTS WEST!

☞ At SEDALIA, WARRENSBURG and PLEASANT HILL, with Stage Lines for Warsaw, Quincy, Bolivar, Springfield, Clinton, Osceola, Lamar, Carthage, Granby, Neosho, Baxter Springs, Fort Gibson, Fort Smith, Van Buren, Fayetteville, Bentonville.

PALACE SLEEPING CARS on all NIGHT TRAINS.

Baggage Checked Through Free!

THROUGH TICKETS for sale at all the Principal Railroad Offices in the United States and Canadas. **Be Sure and Get your Tickets over the PACIFIC R. R. OF MISSOURI.**

W. B. HALE, Gen. Pass. and Ticket Agt.
THOS. McKISSOCK, General Superintendent

61 Miles the Shortest Line!

— FROM —

CHICAGO TO NEW YORK.

Pitts., Ft. Wayne & Chicago

— AND —

PENNSYLVANIA CENTRAL

IS THE ONLY ROUTE

Running its Entire Trains THROUGH to Philadelphia and New York, and the only Route running Three Daily Lines of Pullman Day and Sleeping Palaces, from Chicago to

PITTSBURGH, HARRISBURG,

PHILADELPHIA & NEW YORK,

☞ WITHOUT CHANGE! ☜

WITH BUT ONE CHANGE TO

BALTIMORE, PROVIDENCE, NEW HAVEN, HARTFORD, SPRINGFIELD, WORCESTER & BOSTON!

AND THE MOST DIRECT ROUTE TO WASHINGTON.

☞ Trains Leave WEST SIDE UNION DEPOT, corner West Madison and Canal Streets, as follows:

	Mail.	Fast Express.	Pacific Exp.	Night Exp.
Leave—CHICAGO	5.30 A. M.	9.00 A. M.	5.15 P. M.	9.00 P. M.
Arrive—PLYMOUTH	9.50 "	12.03 P. M.	8.45 "	12.35 A. M.
" FORT WAYNE	12.30 P. M.	2.05 "	11.15 "	3.10 "
" LIMA	3.24 "	4.06 "	1.23 A. M.	5.40 "
" FOREST	4.43 "	5.08 "	2.45 "	7.07 "
" CRESTLINE	6.20 "	6.30 "	4.20 "	8.55 "
Leave—CRESTLINE	6.00 A. M.	6.50 "	4.30 "	9.35 "
Arrive—MANSFIELD	6.40 "	7.17 "	5.00 "	10.05 "
" ORRVILLE	9.15 "	9.05 "	6.54 "	11.55 "
" ALLIANCE	11.10 "	10.40 "	8.30 "	1.30 P. M.
" PITTSBURGH	3.45 P. M.	1.55 A. M.	12.10 P. M.	4.40 "
" CRESSON	11.57 "	5.44 "	4.48 "	10.00 "
" ALTOONA	12.48 A. M.	6.55 "	5.55 "	2.40 A. M.
" HARRISBURG	5.30 "	11.25 "	10.45 "	2.50 "
" PHILADELPHIA	6.50 "	3.15 "	3.00 "	6.50 "
" NEW YORK, VIA PHILADELPHIA	10.30 "	6.30 "	6.41 "	10.30 "
" NEW YORK, VIA ALLENTOWN	10.30 "	6.30 "	.....	10.30 "
" BALTIMORE	9.15 P. M.	3.05 "	2.30 A. M.	9.15 P. M.
" WASHINGTON	1.00 "	5.15 "	5.45 "	1.00 "
" BOSTON	9.00 "	5.50 A. M.	6.00 "	9.00 "

Boston and New England Passengers will find this Route especially Desirable, as it gives them an opportunity of Seeing the FINEST VIEWS AMONG THE ALLEGHANY MOUNTAINS,

Besides Visiting PITTSBURGH, PHILADELPHIA and NEW YORK, without extra cost!

☞ All New England Passengers holding Through Tickets will be Transferred, with their Baggage, to Rail and Boat Connections in NEW YORK, **Without Charge!**

THROUGH TICKETS for sale at the Company's Offices, at 65 Clark St.; 52 Clark St.; cor. Randolph and LaSalle Sts.; and at Depot, Chicago. Also at Principal Ticket Offices in the West.

CLOSE CONNECTIONS Made at LIMA for all Points on the Dayton & Michigan and the Cincinnati, Hamilton & Dayton Railways, and at CRESTLINE for Cleveland and Columbus.

Express Trains are Equipped with WESTINGHOUSE AIR BRAKES,

The Most Perfect Protection Against Accidents in the World!

F. R. MYERS, Gen. Pass. & Tkt Agt. P. F.W. & C. R'y Chicago.

W. C. CLELAND, Gen. Western Pass. Agt. P. F. W. & C. R'y, Chicago.

T. L. KIMBALL, Gen. Western Pass. Agt. Penn. Cen. R. R. Chicago.

Broad Gauge! Double Track!

ERIE RAILWAY.

4 EXPRESS TRAINS DAILY!

From Cleveland, Dunkirk and Buffalo, 625 Miles, to New York, WITHOUT CHANGE of Coaches!

☞ The Trains of this Railway are run in DIRECT CONNECTION WITH ALL WESTERN AND SOUTHERN LINES, for

Elmira, Williamsport, Oswego, Great Bend, Scranton, Newburgh,

NEW YORK, ALBANY, BOSTON, PROVIDENCE,

AND PRINCIPAL NEW ENGLAND CITIES.

New and Improved DRAWING ROOM COACHES are attached to the DAY EXPRESS Running THROUGH TO NEW YORK.

☞ **SLEEPING COACHES,** Combining all Modern Improvements, with perfect Ventilation and the peculiar arrangements for the comfort of Passengers incident to the **BROAD GAUGE,** accompany all night trains to New York.

CONNECTIONS CERTAIN! as Trains on this Railway will, when necessary, **wait from one to two hours for Western trains.**

All Trains of Saturday run directly Through to New York.

☞ **Ask for Tickets via Erie Railway,** which can be procured at **66 Clark Street,** Chicago, and at all Principal Ticket offices in the West and Southwest.

L. D. RUCKER, Gen'l Superintendent, New York.

A. J. DAY, Western Passenger Agent, Chicago.

WM. R. BARR, Gen'l Passenger Agent, New York.

Pan-Handle

— AND —

Penn'a Central Route East!

☞ SHORTEST AND QUICKEST ROUTE, VIA COLUMBUS, TO ☜

PITTSBURGH, BALTIMORE, PHILADELPHIA & NEW YORK

On and after Sunday, NOVEMBER 20th, 1870, Trains for the East will run as follows:

[DEPOT CORNER CANAL AND KINZIE STS., WEST SIDE.]

7:40 A. M. DAY EXPRESS.

[SUNDAYS EXCEPTED.] Via Richmond. Arriving at

COLUMBUS	3:00 A. M.	HARRISBURG	10:35 P. M.	NEW YORK	6:40 A. M.	WASHINGTON	5:45 A. M
PITTSBURGH	12:15 M.	PHILADELPHIA	3:10 A. M.	BALTIMORE	2:30 A. M.	BOSTON	5:05 P. M

7:10 P. M. NIGHT EXPRESS.

[SUNDAYS EXCEPTED.] Arriving at:

COLUMBUS	11:15 A. M.	HARRISBURG	5:20 A. M.	NEW YORK	11:40 A. M.	WASHINGTON	1:10 P. M
PITTSBURGH	7:25 P. M.	PHILADELPHIA	9.50 A. M.	BALTIMORE	9:30 A. M.	BOSTON	11:50 P. M

Palace Day and Sleeping Cars

Run Through to COLUMBUS, and from Columbus to NEW YORK, WITHOUT CHANGE!

ONLY ONE CHANGE TO NEW YORK, PHILADELPHIA, OR BALTIMORE!

CINCINNATI & LOUISVILLE AIR LINE SOUTH.

35 Miles the Shortest Route to Cincinnati.
18 Miles the Shortest Route to Indianapolis and Louisville.

3 Hours the Quickest Route to Cincinnati!

THE SHORTEST AND BEST ROUTE TO

Columbus, Chillicothe, Hamilton, Dayton, Wheeling, Zanesville, Parkersburg, Marietta, Evansville, Lexington, Terre Haute, Nashville,

ALL POINTS IN CENTRAL & SOUTHERN OHIO, & INDIANA, KENTUCKY & VIRGINIA.

— QUICK, DIRECT AND ONLY ALL RAIL ROUTE TO —

New Orleans, Memphis, Mobile, Vicksburg, Charleston, Savannah,

AND ALL POINTS SOUTH.

Cincinnati, Indianapolis and Louisville Trains run as follows:

THROUGH WITHOUT CHANGE OF CARS!

7.40 A. M. (Sundays excepted) Arriving at

LOGANSPORT	1:15 P. M.
KOKOMO	2:33 P. M.
CINCINNATI	10:10 P. M.
INDIANAPOLIS	5:00 P. M.
LOUISVILLE	11:30 P. M.

8.05 P. M. (Saturdays excepted.) Arriving at

LOGANSPORT	1:15 A. M.
KOKOMO	2:31 A. M.
CINCINNATI	9:35 A. M.
INDIANAPOLIS	5:40 A. M.
LOUISVILLE	3:00 P. M

Lansing Accommodation: Leaves 3:40 P. M. Arrives 10:55 A. M.

PULLMAN'S PALACE SLEEPING CARS!

Accompany all Night Trains between Chicago and Cincinnati or Indianapolis.

☞ Ask for Tickets **via COLUMBUS** for the East, and **via "The AIR LINE"** for Cincinnati, Indianapolis, Louisville and points South. Tickets for sale and Sleeping Car Berths secured at **95 RANDOLPH STREET, CHICAGO,** and at Principal Ticket Offices in the West and Northwest.

WM. L. O'BRIEN, Gen. Pass. and Ticket Agent, Columbus.

I. S. HODSDON Northwestern Pass. Agt. Chicago.

D. W. CALDWELL Gen Supt. Columbus.

The Great Favorite Route for Missouri, Nebraska and Iowa.

KANSAS CITY, ST. JOSEPH

— AND —

COUNCIL BLUFFS

☞ THROUGH LINE! ☜

3 EXPRESS PASSENGER TRAINS Leave Union Depot Daily, on the arrival of Eastern Southern and Western Trains, crossing the Missouri River on the New Iron Bridge at KANSAS CITY, passing the cities of

LEAVENWORTH, ATCHISON, SAINT JOSEPH,

— AND —

NEBRASKA CITY.

Connecting at COUNCIL BLUFFS with Iowa Lines for all prominent points in Iowa, and making DIRECT CONNECTION at **OMAHA** with the Great **Union Pacific Railroad,** for

CHEYENNE, DENVER, SALT LAKE, SACRAMENTO, SAN FRANCISCO

And the Pacific Coast.

Pullman's Palace Sleeping Cars!

ON ALL NIGHT TRAINS.

☞ Ask for Tickets via the People's Favorite Route, **Kansas City, St. Joseph & Council Bluffs Railroad Line.**

A. L. HOPKINS, Gen. Superintendent ST. JOSEPH, Mo.

A. C. DAWES, Gen. Passenger Agent, ST. JOSEPH, Mo.

THE RAILROAD GAZETTE.

A Weekly Journal of Transportation, Engineering and Railroad News.

Devoted to the Discussion of Subjects Connected with the Business of Transportation, and the Dissemination of Railroad News.

Illustrated Descriptions of Engineering Works and Railroad Machinery and Rolling Stock.

Contributions from Practical Railroad Men, on the Business of Railroading.

A Complete Record of Railroad News.

NEW ORGANIZATIONS. *ENGINEERING AND MECHANICS.*

PROGRESS OF NEW ROADS. *TRAFFIC AND EARNINGS.*

ELECTIONS AND APPOINTMENTS. *LAKE AND RIVER NAVIGATION.*

RAILROAD LAW. *RAILROAD MANUFACTURES.*

The Cream of the American and European Technical Periodicals.

An Impartial and Independent Journal, Valuable to Every Railroad Man.

TERMS OF SUBSCRIPTION:

Single copy, per annum,.....$4.00 | Eight copies, per annum, and one to the person who gets up the club.....$30.00

Three copies, per annum,.....11.00

Subscriptions for One Year or less will be received up to Jan. 1st, at $3.00 a Year.

ADVANCE PAYMENT is required.

CANADA SUBSCRIBERS, twenty-five cents additional.

SINGLE COPIES, ten cents each.

ADVERTISING RATES will be made known on application.

Address— A. N. KELLOGG, Publisher,

101 Washington St., Chicago

"Has always been one of the best papers of the country for railroad intelligence."—[New York Commercial and Financial Chronicle.

"Has always been one of the most valuable publications in the West * * * Is bound to continue its sway as the leading railroad journal of the country.—[Sedalia (Mo.) Bazoo.

"In its financial and commercial views in connection with the railroad interests of the country, may be regarded as one of the first papers of the United States."—[Pensacola Observer.

"As it devotes much attention to Southern railroad and industrial interests, it is always interesting to Southern readers."—[Galveston News.

"For railroad men and others wishing to keep themselves thoroughly posted on railroad matters we know of no better paper."—[Madison State Journal.

"One of our most valuable exchanges. * * * Its columns teem with reliable information of great benefit to railroad men of every section of the United States."—[Leavenworth Bulletin.